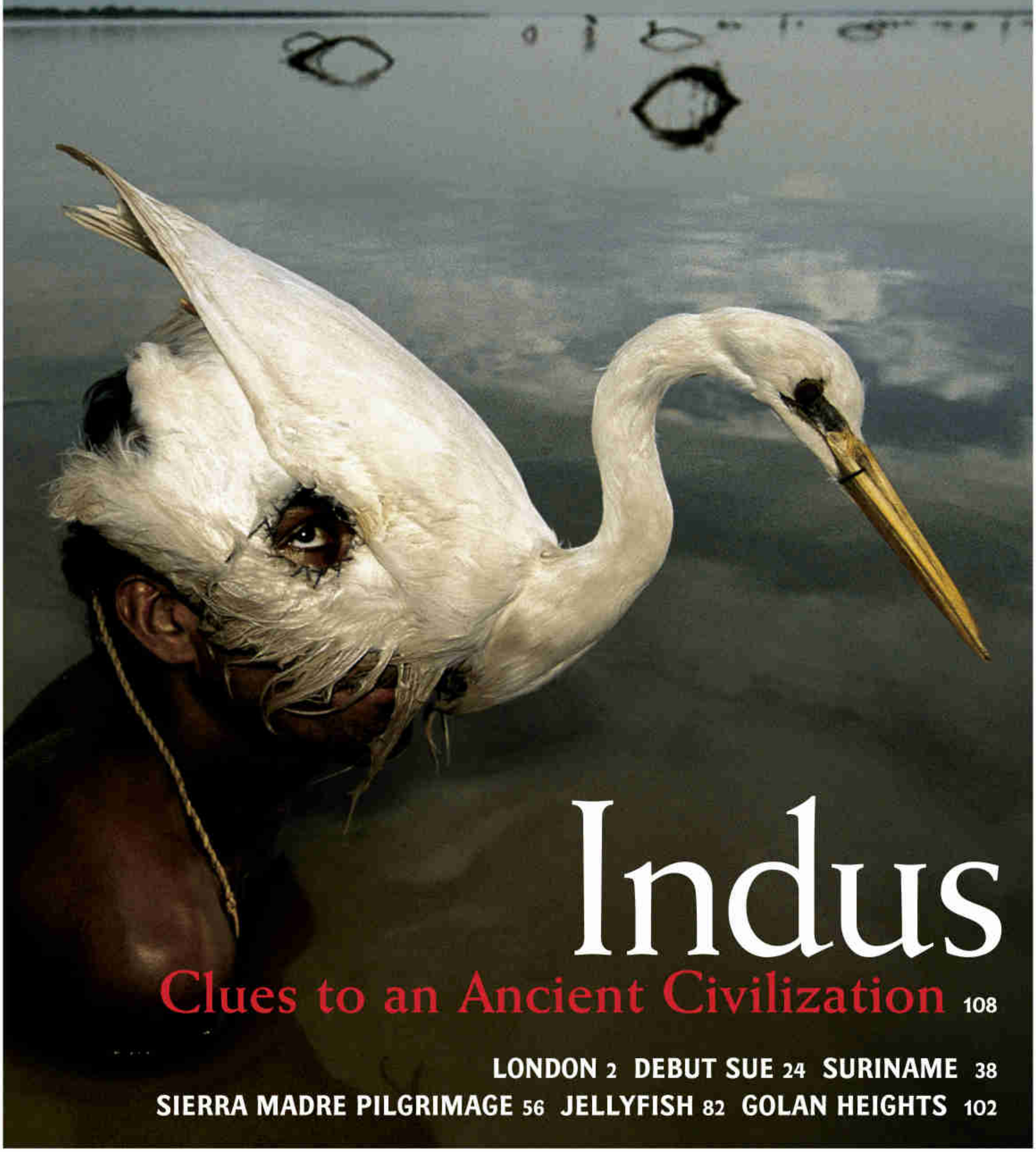
VOL. 197, NO. 6 JUNE 2000

NATIONAL GEOGRAPHIC



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CASTLE DUNLUCE, ANTRIM, NORTHERN IRELAND

A Traveler's Map of BRITAIN & IRELAND

Produced by National Geographic Maps for National Geographic Magazine

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Washington, D.C., June 2000

SHETLAND ISLANDS

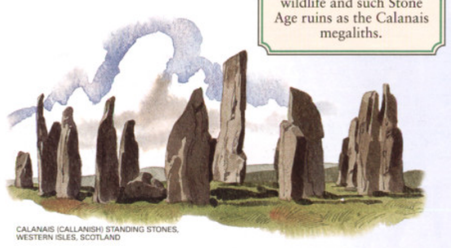
Once a Viking stronghold, Great Britain's most remote island group harbors ruins from the Stone, Bronze, and Iron Ages. Well-known natives of these nearly treeless isles include the diminutive Shetland pony and the Shetland sheepdog, both called shelties.

SCOTTISH HIGHLANDS

Glaciers carved northern Scotland into a jumble of mountains, moors, glens, lochs, and rugged shorelines. This land of tartan-clad families, or clans, offers superlative fishing in racing streams tucked amid small sheep farms.

WESTERN ISLES

Scottish Gaelic is spoken on these remote but long-settled islands, also called the Outer Hebrides. The 130-mile-long archipelago is known for abundant wildlife and such Stone Age ruins as the Calanais megaliths.



CALANAIS (CALLANISH) STANDING STONES, WESTERN ISLES, SCOTLAND

ULSTER

Northern Ireland draws many visitors despite the "Troubles." Belfast's opulent Grand Opera House features dramas as well as operas. Rural attractions include the Giant's Causeway, the Erne lakes, and the Mourne Mountains.

GALWAY & CONNEMARA

Exuberant nightlife animates the city of Galway, an old port with bohemian flair. Ferries serve the stony Aran Islands, and nearby Connemara National Park beckons with its wild stretches of mountains, bogs, and heath.

Map Legend

- Limited-access highway
- Other road
- Canal
- High-speed railroad
- Other passenger railroad
- Airport
- International airport
- Pass
- KENT Geographic county or region
- Abbey, church, or priory
- Battle
- Castle
- Cathedral
- National nature reserve
- Palace or mansion
- Prehistoric ruin
- Roman ruin
- Other place of interest

Vegetation and Land Use

Cropland, Grassland, Moor, Urban area

Polyconic Projection

SCALE 1:1,829,000 or 1 INCH = 28.9 MILES

0 25 50 75 100 STATUTE MILES

0 25 50 75 100 KILOMETERS

BRITAIN & IRELAND

Britain or Great Britain, the largest island in Europe, is composed of England, Scotland, and Wales. These, along with Northern Ireland, constitute the United Kingdom. The Republic of Ireland comprises most of the island of Ireland.

Art by Matthew Cook
Relief by John A. Bonner

GALWAY & CONNEMARA

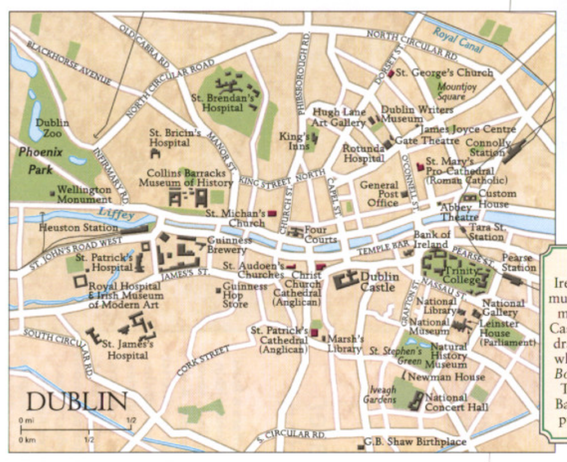
Exuberant nightlife animates the city of Galway, an old port with bohemian flair. Ferries serve the stony Aran Islands, and nearby Connemara National Park beckons with its wild stretches of mountains, bogs, and heath.

COUNTY CORK

Here the Blarney Stone bestows the gift of eloquence on those who kiss it, legend says. Cobh was a major embarkation point for emigration during the potato famine of 1845-1851. Midleton is home to Irish Distillers, the country's largest whiskey maker.



COBH, COUNTY CORK, IRELAND



DUBLIN

Ireland's capital contains much of the nation's patrimony, including Dublin Castle, St. Patrick's Cathedral, and Trinity College, where the early medieval *Book of Kells* is on view. The revitalized Temple Bar neighborhood offers pubs and trendy shops.



SNOWDONIA, WALES

SNOWDONIA

A haven for hikers, this sprawling national park in northern Wales features waterfalls and rugged peaks, including 3,560-foot Mount Snowdon.



BATH ABBEY, ENGLAND

THE WEST COUNTRY

The legend of King Arthur haunts this land of moor, cave, valley, and green dairyland that yields celebrated cheddar cheese and Devonshire cream. Sandy coves and picturesque fishing villages attract tourists, as do the Roman ruins and Georgian town houses of Bath.

ISLE OF MAN

Viking burial grounds and Celtic crosses dot this crown possession, which has its own governing body and issues its own currency and stamps.

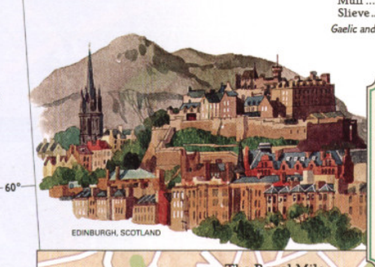
CHANNEL ISLANDS

Governed by their own elected assemblies, these French-flavored isles export prime dairy cattle from Guernsey and Jersey.

PITMEDDEN GARDENS, SCOTLAND

EDINBURGH

Scotland's graceful capital proudly flaunts its cultural heritage, especially during the International Festival in late summer. Edinburgh will see its prominence grow now that Scotland has its own Parliament, a step toward greater political autonomy.



EDINBURGH, SCOTLAND



LONDON

Seat of government and treasure-house of British culture, London still glints with the pomp and pageantry befitting the empire it once ruled. Stately architecture is complemented by the flash and verve of a city brimming with renewed vitality.





LONDON EYE OBSERVATION WHEEL, LONDON, ENGLAND

LAKE DISTRICT

Wordsworth, Coleridge, and other poets celebrated the wild prospects of this region of northwestern England with its 16 major lakes and dozens of fells, or hills, more than 2,000 feet high. Boaters, rock climbers, and bicyclists are drawn to Lake District National Park, one of the most popular in Britain.

THAMES VALLEY

Springing from the Cotswold Hills, the River Thames begins its 215-mile journey. It flows past Oxford University, Eton, Windsor Castle, and Hampton Court and becomes the artery of London before emptying into the North Sea.

Geographic Equivalents

Ben	mountain
Broch	prehistoric round tower
Cairn	monument of rough stones
Cill	church
Dun	hill fort
Firth	estuary, strait
Glen	narrow steep-sided valley
Kyle	sound, strait
Llan, Llanfair	church, church of Mary
Loch, lough	lake, fjord
Moor	open rolling infertile land
Mull	headland, promontory
Sliev	hill, mountain

Gaelic and Welsh place names shown in parentheses

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Post Office
Point of interest
Theater
Guided boat tour
River bus
Hotel
Chapel
Church
Synagogue
Notable building
Railroad station
Underground station
Park
A road
B road
Main road
Other road
One-way street
Pedestrian area
Tunnel

SCALE 1:10,000

Greater London

London offers a feast of attractions within a metropolis of seven million people. A vibrant theater district complements distinguished art galleries and grand museums. A variety of architectural styles and monuments reflects eras of the city's history from Roman outpost to seat of empire to global trendsetter.

The London Experience

CULTURE • HISTORY • CONTEMPORARY LIFE

1 Royal Albert Hall
Named by Queen Victoria for her husband, Prince Albert, this imposing building was modeled after Roman amphitheaters and hosts a variety of events, including the popular annual BBC Proms summer music festival.

2 Science Museum
Seven floors display exhibits ranging from steam engines and locomotives to space exploration and the latest developments in computer science.

3 Natural History Museum
Celebrating and explaining the natural world, this popular museum includes an earthquake experience, a display of life-size robotic dinosaurs, mammals from around the globe, and exhibits on human biology and evolution.

4 Harrods
Begun as a small grocery, London's most famous department store is known for its astonishing array of goods—from teddy bears to 150 varieties of whiskey.

5 Hyde Park
Once part of Westminster Abbey's grounds, Hyde Park features swimming and boating in the Serpentine, an artificial lake. At Speakers' Corner long-winded orators declaim on every conceivable subject.

6 Oxford Street
Shops small and large, including the immense Selfridges department store, offer clothing, accessories, and music in what is perhaps London's most popular shopping district.

7 Mayfair
The fashionable Mayfair district is a magnet for affluent shoppers as well as one of the most elegant residential areas of Georgian architecture.

8 Buckingham Palace
Tourists flock to witness the colorful Changing of the Guard and to cheer occasional appearances by the royal family on the balcony. The city home of Elizabeth II and her husband, the Duke of Edinburgh, the palace has 600 rooms and a full-time staff of about 300.

9 Westminster Cathedral
Architect John Bentley mixed Byzantine and Romanesque styles to differentiate his late 19th-century Roman Catholic structure from the Church of England's Westminster Abbey. The campanile offers sweeping views of the city.

10 Houses of Parliament
Visitors may watch the House of Commons and House of Lords in session, highlighted by the Prime Minister's Question Time on Wednesdays, but tickets must be obtained in advance.

11 Westminster Abbey
The monarch is crowned in this richly appointed and towering structure, site of an abbey church begun by Edward the Confessor in 1050. After the monastery was dissolved in 1540, it was named the Collegiate Church of St. Peter at Westminster.

12 Big Ben
A name often misapplied to the famous four-faced clock on the tallest Houses of Parliament tower; Big Ben is actually the bell that chimes the hours.

13 Horse Guards
The ceremonial mounting of the guard by the Queen's personal cavalry takes place each morning—with dismounting in late afternoon—at Horse Guards Parade, London's most famous parade ground.

14 Trafalgar Square
A popular site for public demonstrations and lively New Year's Eve celebrations, the square commemorates Britain's decisive victory over Napoléon at Trafalgar, Spain, and is dominated by a column and statue of the battle's hero, Admiral Lord Nelson.

15 National Gallery
London's most important art museum holds more than 2,200 paintings and is particularly strong in Dutch, Italian Renaissance, and 17th-century Spanish works.

16 Piccadilly Circus
Garish neon signs and a statue known as Eros (actually the Angel of Christian Charity) mark Piccadilly, gateway to the movie houses, theaters, and nightclubs of the Trafalgar and Soho area.

17 British Museum
A monumental collection of some seven million items includes Egyptian mummies; Assyrian, Greek, and Roman artifacts; the Rosetta stone, which enabled the deciphering of Egyptian hieroglyphics; and the Elgin Marbles from the Parthenon in Athens.

18 Covent Garden
Jugglers, musicians, and acrobats perform in the traffic-free piazza opposite the city's best known market, focal point of this revitalized district of specialty shops, antique stalls, and cafés.

19 The Strand
Formerly a beach, or strand, before the building of Victoria Embankment, this area is notable for theaters and such distinguished buildings as the Tudor-period Queen's Chapel of the Savoy and classical Somerset House.

20 The Temple
Once occupied by the Knights Templar, who protected Holy Land pilgrims in medieval times, the Temple complex includes two of the four Inns of Court, where British barristers are trained.

21 Smithfield Market
Locals recommend an early morning (before 8 a.m.) visit to this wholesale meat market, followed by a hearty breakfast at one of the nearby pubs.

22 St. Paul's Cathedral
A baroque cathedral entombing its architect, Sir Christopher Wren, St. Paul's was consecrated in 1711. It witnessed the funerals of Admiral Lord Nelson and Sir Winston Churchill and was the site of the wedding of Prince Charles and Lady Diana in 1981.

23 City of London
Usually referred to simply as the City, the metro area's business and financial center lies on the site of the Romans' original settlement, called Londinium.

24 South Bank
The new London Eye observation wheel overlooks a once derelict swath of the Thames's south bank between Tower and Westminster Bridges, an area now enlivened by theaters, concert halls, and the London Aquarium.

25 Imperial War Museum
Replicas of a World War I trench and a London street ravaged by World War II bombs stand alongside exhibits of guns, planes, and tanks. The "Secret War" exhibit illuminates the shadow world of undercover espionage.

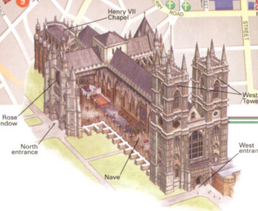
26 Tate Modern
Spawned by the venerable Tate Gallery, the new Tate Modern displays works by Matisse, Picasso, Pollock, Dali, and many other 20th-century luminaries. Boat service links the sister Tates.

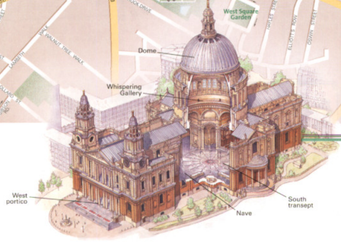
27 Globe Theatre
Opened in 1599 and twice destroyed, the Globe staged plays by Shakespeare and Ben Jonson. A replica, opened in 1997 near the original site along the Thames, re-creates the wooden, tiered circular seating. It is central London's first thatched structure built since the Great Fire of 1666.

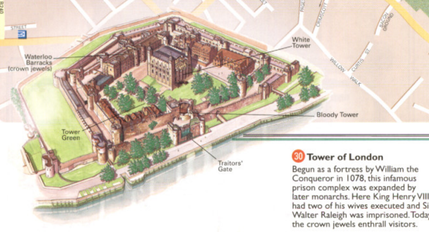
28 H.M.S. *Belfast*
Docked on the rejuvenated south bank of the Thames, the H.M.S. *Belfast*, a World War II Royal Navy cruiser, is still equipped with sailors' quarters and weapons.

29 Tower Bridge
Its Gothic design was mandated to complement the nearby Tower of London, but the structure, opened in 1894, is a modern drawbridge. Powered by coal-fed steam boilers until electrification in 1976, the bridge can be raised in 90 seconds.

30 Tower of London
Begun as a fortress by William the Conqueror in 1078, this infamous prison complex was expanded by later monarchs. Here King Henry VIII had two of his wives executed and Sir Walter Raleigh was imprisoned. Today the crown jewels enthrall visitors.









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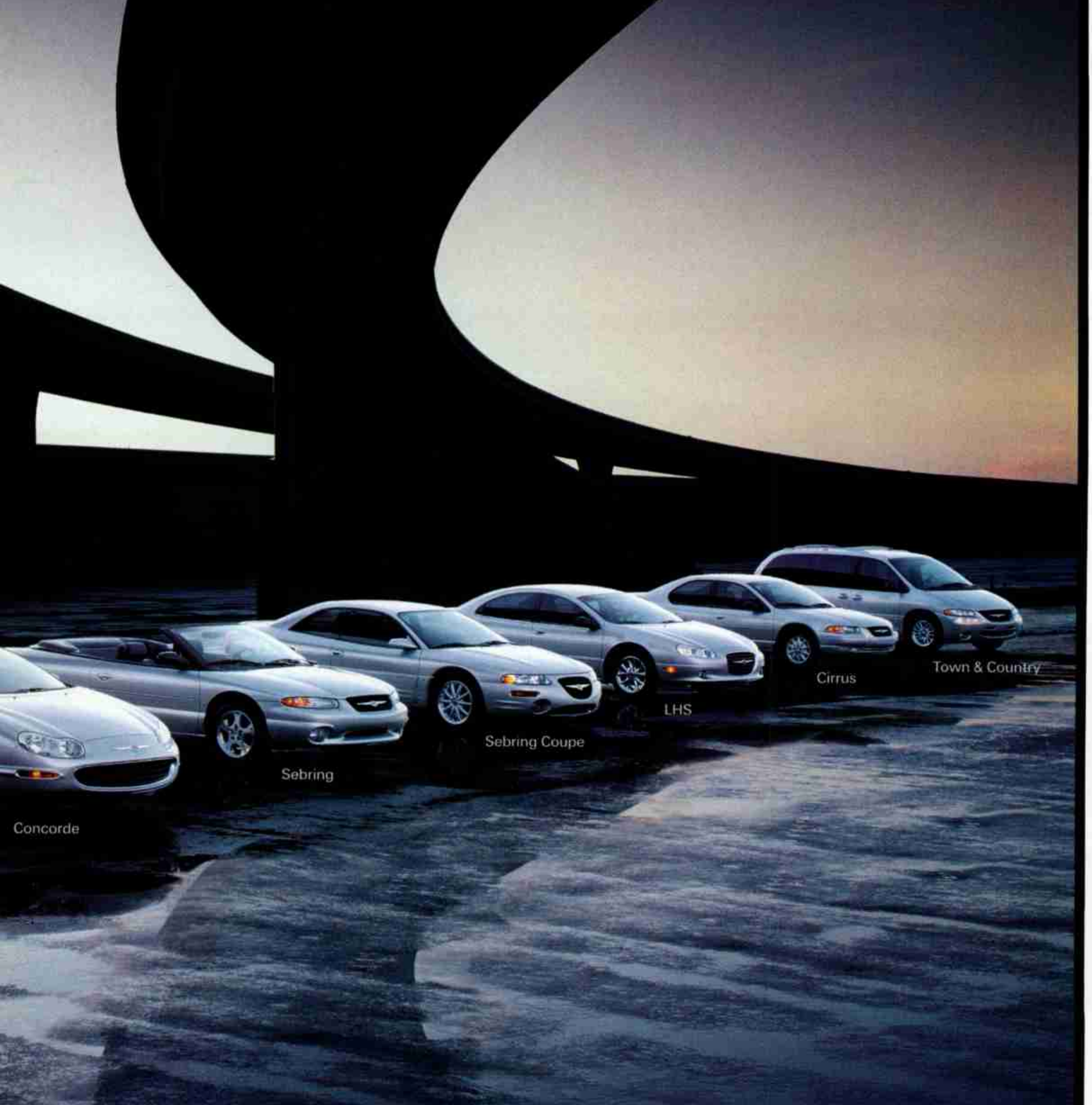
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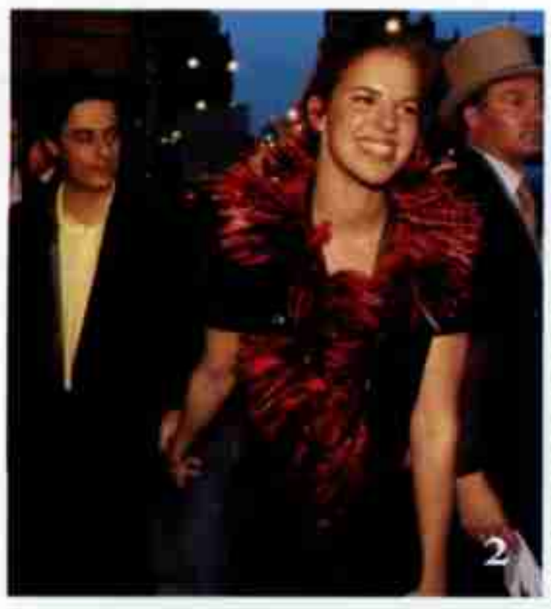


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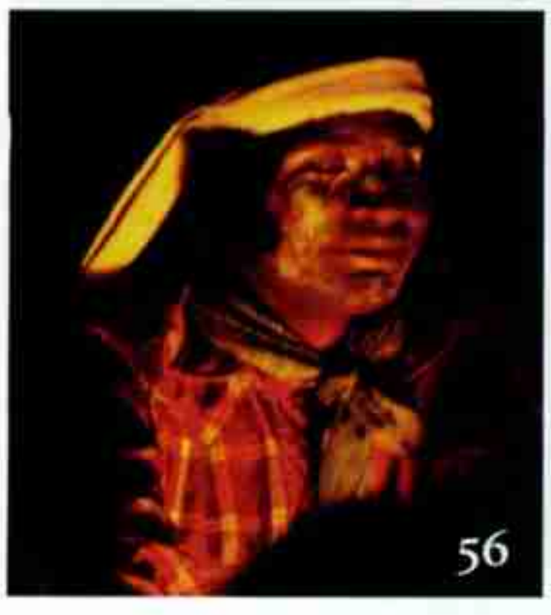
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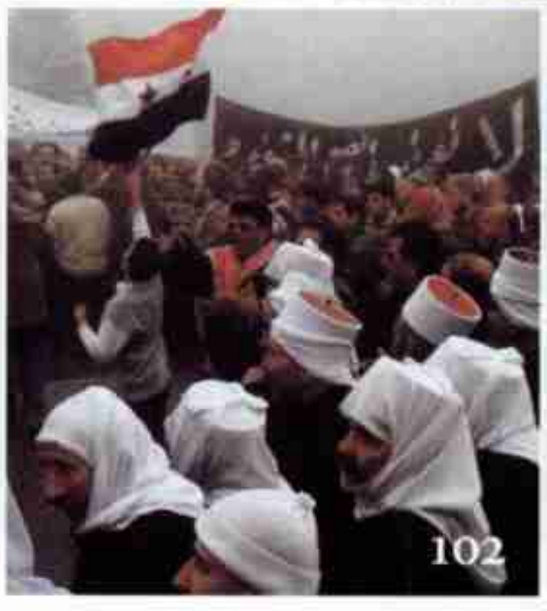


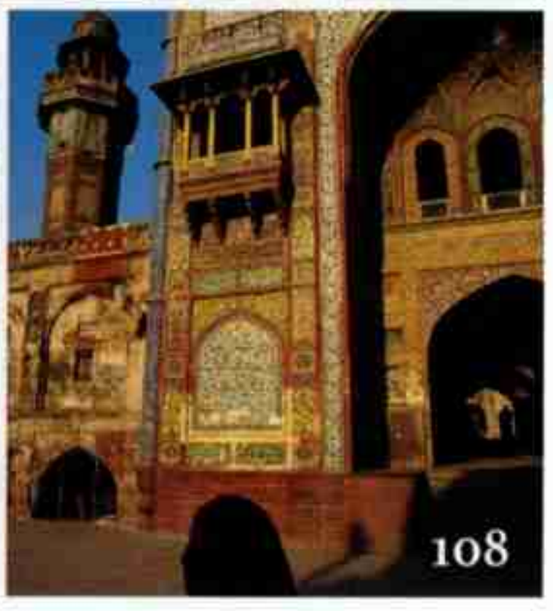












2 **London** *Britain's capital city has shed its staid reputation. Newly enlivened by hot culture and cold cash, London is redefining itself as a global trendsetter.*
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108 **Indus Civilization** *Archaeologists unearth clues to ancient cities—long disappeared—that once flourished in the Indus Valley of Pakistan and northwestern India.*
BY MIKE EDWARDS PHOTOGRAPHS BY RANDY OLSON

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The Cover

A hunter near Mohenjo Daro, Pakistan, uses an egret headdress as a decoy to stalk birds on the Indus River. Photograph by Randy Olson

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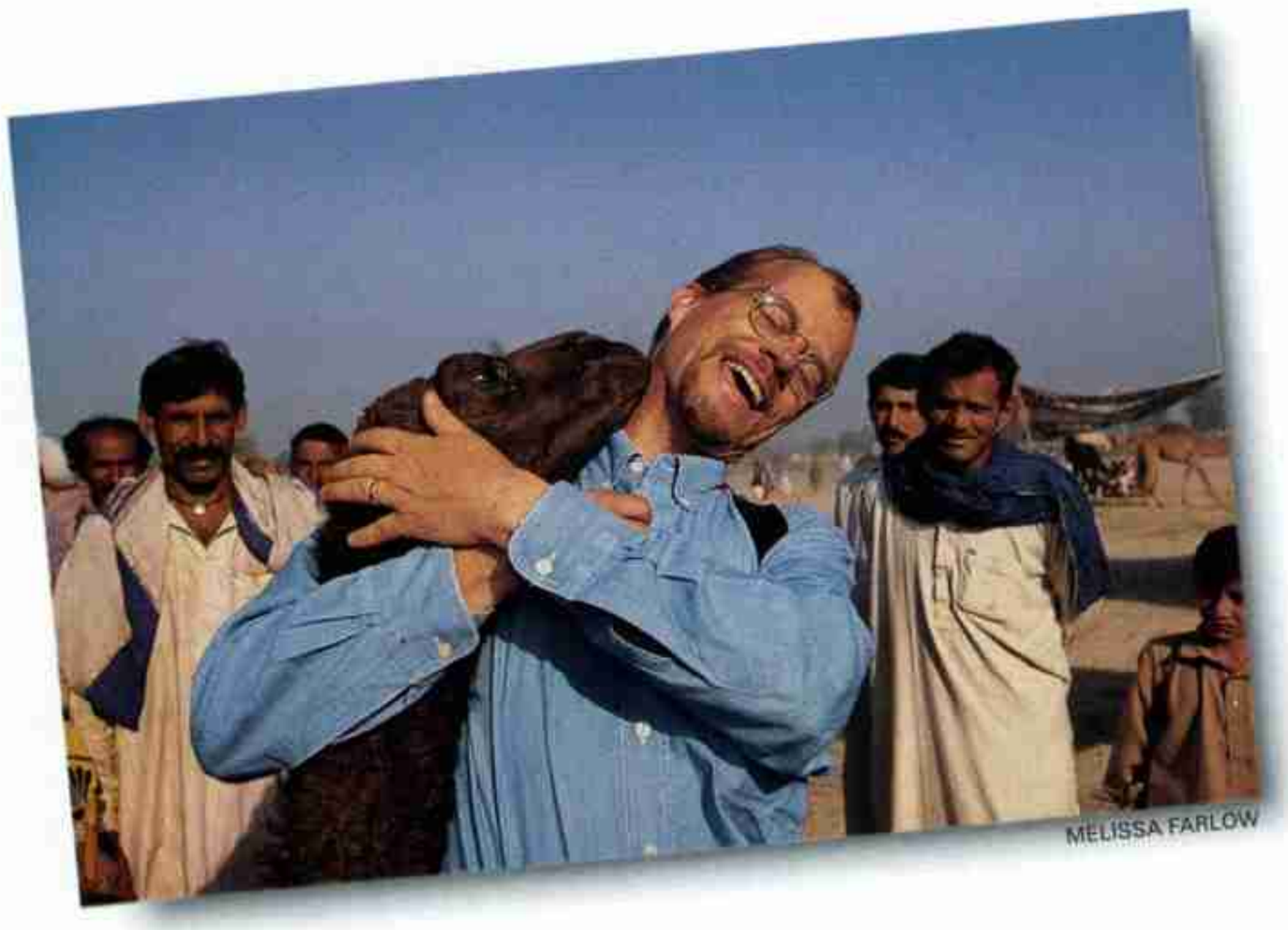


NGS PHOTOGRAPHER JODI COBB

■ LONDON

Fans Are All Shook Up

"They needed work on their harmony but not on their attitude," says photographer Jodi Cobb, who was serenaded by these fun-loving British football fans outside London's Wembley Stadium. She discovered this troupe of Elvises dressed in the Newcastle United soccer team's black-and-white just before a match with Manchester United.



MELISSA FARLOW

■ INDUS CIVILIZATION

Dodging a Kiss

"It's kind of like a motorcycle rally, except with camels," says Randy Olson of the annual *mela,* or fair, he visited outside Harappa, Pakistan. A lot friendlier than a motorcycle, this baby camel was one of thousands of camels brought to the tomb of Mohammad Panah, a saint who was said to heal the beasts. Randy's wife, photographer Melissa Farlow, was often the focus of attention at the mostly male gathering, even though she tried to blend in by wearing local dress. "Sometimes she had to walk off in the opposite direction just so I could work," Randy says.

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Weaving Technology to Dye For

The technique of weaving cloth first arrived in Japan from China around 300 B.C. After archaeologists found 40 textile fragments from the first century B.C. to the third century A.D. on the island of Kyushu, a Kyoto Institute of Technology team decided to use traditional methods to re-create the original silk and hemp fabrics. It wasn't easy. The team analyzed the cloth's makeup, thread width, and density of the weave under a microscope, then asked skilled artisans to make a nobleman's silk tunic (left) and a commoner's hemp jacket. Experts dyed the silk red using extracts from an herb called madder. "It was much more difficult than we expected to dye it evenly," says Susumu Shirai of Tatsumura Art Textiles. Other craftsmen had even more trouble spinning coarse hemp fibers into a fragile thread a hundredth of an inch in diameter. "It seems techniques of making hemp cloth had already reached their most sophisticated point in Japanese history," said one artisan.

Out of Africa, Into Europe

In 1991 scientists unearthed a puzzling jawbone beneath ruins of a medieval village in Dmanisi in the republic of Georgia (GEOGRAPHIC, May 1997). According to David Lordkipanidze, coordinator of the Georgian team, the estimated 1.7-million-year-old jaw looked like that of a human ancestor, *Homo ergaster.* But that hominid had never before been found outside Africa. Last year excavators at Dmanisi discovered two skulls clearly identifiable as *H. ergaster.* Stone tools lay nearby. "This may be the oldest hominid site yet found in western Eurasia," says Lordkipanidze.



JUNRO NUNOME (TOP); GOURAM TSIBAKHASHVILI

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Rebirth for a Classic Sculpture?

In 1791 William Rush, the United States' first great sculptor, carved a wooden figurehead of an Indian trader for the *William Penn*, a trading vessel. But after she was sold in 1802, the ship vanished from the historical record.

Two centuries later the figurehead may have come to light. A research team believes a seven-and-a-half-foot-high wood carving bought by antiques collector Peter Hill at a San Francisco auction in 1985 once graced the *William Penn*.

"It's as close a fit as you can hope to get," says R. Mark Adams, a conservator who led the lengthy research effort. The team is convinced that the smiling figure is Tamanend, a chief of the Delaware Indians who signed a treaty with William Penn in 1683. Though Rush was famed for his Indian figures, none was known to survive. Hill has commissioned a clay model, at far left, and hopes a museum will accept and restore the wood carving.





BOTH BY DAVID PUTNAM



JOHN TENNIEL

A Tea Party for Health

Maybe Lewis Carroll's Mad Hatter was on to something at his tea party (above). Flavonols —chemical compounds linked to natural sugars—found in tea lessen the oxidizing process associated with heart disease, cancer, and cataracts. Stick with the likes of Assam, Darjeeling, Ceylon, and Chinese and Japanese green teas, advises Gary Williamson of England's Institute of Food Research, who has studied flavonols in teas; few herbal varieties are known to contain flavonols.

Gold Relics of Viking Times

Tiny gold foils found at sites throughout Scandinavia are offering historians insights into the clothing, hairstyles, and religious practices of the Vikings (GEOGRAPHIC, May 2000). Some of the thumbnail-size foils, called *guldgubber*, date from as far back as the sixth century; later foils have been found at Viking settlements near religious centers. "They may have been bought as tickets to religious feasts," says Per O. Thomsen of Denmark's Svendborg and Omegns Museum, who has excavated guldgubber in southern Denmark. In rare cases they depict animals, but most are embossed with human figures, singly or in pairs. They show details of clothing, such as the man's knee-length cloak and the woman's shawl and ankle-length skirt on the foil at right, shown five times its actual size. Men have brushed-back, shoulder-length hair; women wear their long hair in a bun.



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ELIZA MITCHELL

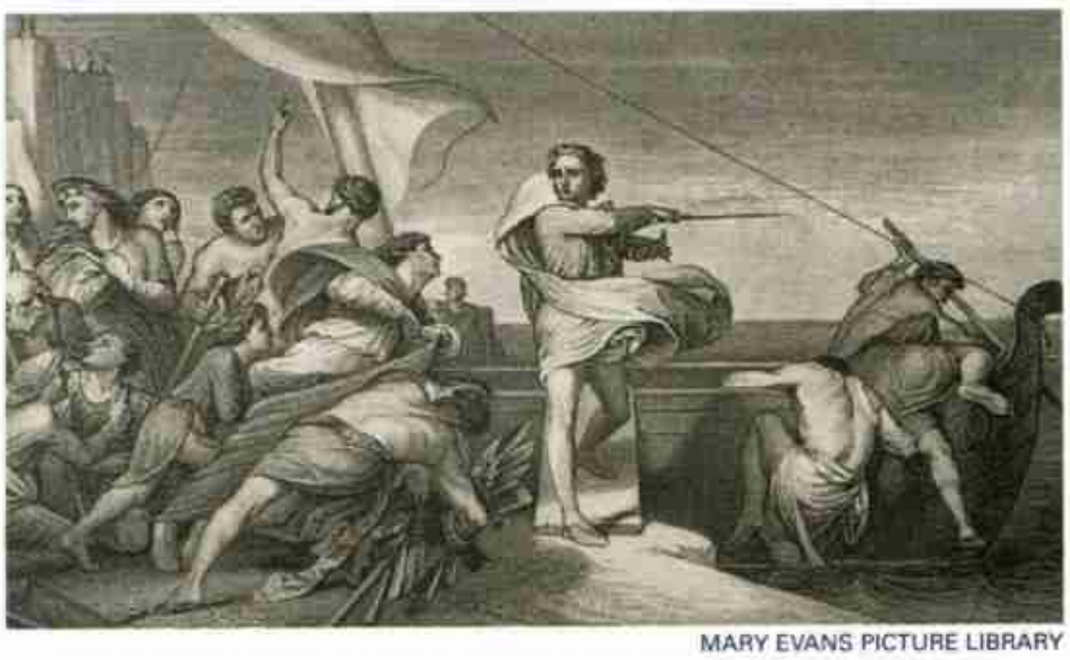
The End of a Way of Life on the Canadian Prairies

Wooden grain elevators—where farmers bring their harvested wheat to be sorted, cleaned, and stored before shipment—once dotted the Prairie Provinces like Canada geese in a cornfield. At their peak in the 1930s more than 5,700 elevators towered over the flatlands of Alberta, Manitoba, and Saskatchewan, symbols of the small farming towns that grew alongside the nation's railroads. But change has come to the traditional way of life in places like Marshall, Saskatchewan (above). Modern highways mean that growers no longer are tied to the rails; they now can use trucks to haul harvested wheat to distant supersilos. Lower grain prices, industry consolidation, and the abolition in 1995 of a century-old subsidy to railroads, which then passed higher costs on to farmers, all hastened the break with the past. Only about a thousand elevators remain in operation, says photographer Eliza Mitchell, who began documenting the prairie landmarks in 1998.

Finding the Grave of a Great King

Alfred the Great fought off Viking attacks (below), inspired scholarship, and masterfully administered his kingdom in southern England—impressive for a ninth-century Saxon ruler.

A British-American team believes it has located Alfred's final grave site—though not his bones—at Hyde Abbey, a wealthy 12th-century church near Winchester. By Alfred's decree, he and his family were buried in a monastery he had ordered built. But England's Norman rulers, who erected Hyde Abbey, signaled its importance by moving the bodies of the king, his wife, Eahlswith, and their son, Edward the Elder, to it. The abbey was razed in the 16th century. Builders of an 18th-century prison on the site removed human remains and three coffins, one of them lead lined. "We found three substantial holes near the church's high altar," says Eric Klingelhofer of Mercer University. A pelvic bone, apparently a woman's, lay in one hole; it will be radiocarbon-dated to see if it could be from Alfred's time.



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I convinced myself that life with erectile dysfunction was fine...

—VIAGRA has shown improvement in erectile function in 4 out of 5 men compared with 1 out of 4 for sugar tablets

—More than 17 million prescriptions written in the United States*

—Effective and well tolerated in a variety of patients

—More than 6 million men in the US have been prescribed VIAGRA (1 million were also taking blood pressure–lowering medication)

...but VIAGRA helped me realize what I was missing.

VIAGRA is not for everyone. Be sure to ask your doctor if your heart is healthy enough to handle the extra strain of sexual activity. If you have chest pains, dizziness, or nausea during sex, stop and immediately tell your doctor.

If you're a man who uses nitrate drugs, never take VIAGRA—your blood pressure could suddenly drop to an unsafe level. With VIAGRA, the most common side effects are headache, facial flushing, and upset stomach. VIAGRA may also briefly cause bluish vision, sensitivity to light, or blurred vision. In the rare event of an erection lasting more than 4 hours, seek immediate medical help. Remember to protect yourself and your partner from sexually transmitted diseases.

Please see patient summary of information about VIAGRA (25-mg, 50-mg, 100-mg) *tablets on the following page.*

*Data on file. Pfizer Inc, New York, NY.

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PATIENT SUMMARY OF INFORMATION ABOUT

VIAGRA®
(sildenafil citrate) tablets

This summary contains important information about VIAGRA®. It is not meant to take the place of your doctor's instructions. Read this information carefully before you start taking VIAGRA. Ask your doctor or pharmacist if you do not understand any of this information or if you want to know more about VIAGRA.

This medicine can help many men when it is used as prescribed by their doctors. However, VIAGRA is not for everyone. It is intended for use only by men who have a condition called erectile dysfunction. **VIAGRA must never be used by men who are taking medicines that contain nitrates of any kind, at any time. This includes nitroglycerin. If you take VIAGRA with any nitrate medicine your blood pressure could suddenly drop to an unsafe or life threatening level.**

What Is VIAGRA?

VIAGRA is a pill used to treat erectile dysfunction (impotence) in men. It can help many men who have erectile dysfunction get and keep an erection when they become sexually excited (stimulated).

You will not get an erection just by taking this medicine. VIAGRA helps a man with erectile dysfunction get an erection only when he is sexually excited.

How Sex Affects the Body

When a man is sexually excited, the penis rapidly fills with more blood than usual. The penis then expands and hardens. This is called an erection. After the man is done having sex, this extra blood flows out of the penis back into the body. The erection goes away. If an erection lasts for a long time (more than 6 hours), it can permanently damage your penis. You should call a doctor immediately if you ever have a prolonged erection that lasts more than 4 hours.

Some conditions and medicines interfere with this natural erection process. The penis cannot fill with enough blood. The man cannot have an erection. This is called erectile dysfunction if it becomes a frequent problem.

During sex, your heart works harder. Therefore sexual activity may not be advisable for people who have heart problems. Before you start any treatment for erectile dysfunction, ask your doctor if your heart is healthy enough to handle the extra strain of having sex. If you have chest pains, dizziness or nausea during sex, stop having sex and immediately tell your doctor you have had this problem.

How VIAGRA Works

VIAGRA enables many men with erectile dysfunction to respond to sexual stimulation. When a man is sexually excited, VIAGRA helps the penis fill with enough blood to cause an erection. After sex is over, the erection goes away.

VIAGRA Is Not for Everyone

As noted above (*How Sex Affects the Body*), ask your doctor if your heart is healthy enough for sexual activity.

If you take any medicines that contain nitrates–either regularly or as needed–you should never take VIAGRA. If you take VIAGRA with any nitrate medicine or recreational drug containing nitrates, your blood pressure could suddenly drop to an unsafe level. You could get dizzy, faint, or even have a heart attack or stroke. Nitrates are found in many prescription medicines that are used to treat angina (chest pain due to heart disease) such as:

- nitroglycerin (sprays, ointments, skin patches or pastes, and tablets that are swallowed or dissolved in the mouth)
- isosorbide mononitrate and isosorbide dinitrate (tablets that are swallowed, chewed, or dissolved in the mouth)

Nitrates are also found in recreational drugs such as amyl nitrate or nitrite ("poppers"). If you are not sure if any of your medicines contain nitrates, or if you do not understand what nitrates are, ask your doctor or pharmacist.

VIAGRA is only for patients with erectile dysfunction. VIAGRA is not for newborns, children, or women. Do not let anyone else take your VIAGRA. VIAGRA must be used only under a doctor's supervision.

What VIAGRA Does Not Do

- VIAGRA does not cure erectile dysfunction. It is a treatment for erectile dysfunction.
- VIAGRA does not protect you or your partner from getting sexually transmitted diseases, including HIV–the virus that causes AIDS.
- VIAGRA is not a hormone or an aphrodisiac.

What To Tell Your Doctor Before You Begin VIAGRA

Only your doctor can decide if VIAGRA is right for you. VIAGRA can cause mild, temporary lowering of your blood pressure. You will need to have a thorough medical exam to diagnose your erectile dysfunction and to find out if you can safely take VIAGRA alone or with your other medicines. Your doctor should determine if your heart is healthy enough to handle the extra strain of having sex.

Be sure to tell your doctor if you:

- have ever had any heart problems (e.g., angina, chest pain, heart failure, irregular heart beats, or heart attack)
- have ever had a stroke
- have low or high blood pressure
- have a rare inherited eye disease called retinitis pigmentosa
- have ever had any kidney problems
- have ever had any liver problems
- have ever had any blood problems, including sickle cell anemia or leukemia
- are allergic to sildenafil or any of the other ingredients of VIAGRA tablets
- have a deformed penis, Peyronie's disease, or ever had an erection that lasted more than 4 hours
- have stomach ulcers or any types of bleeding problems
- are taking any other medicines

VIAGRA and Other Medicines

Some medicines can change the way VIAGRA works. Tell your doctor about **any medicines** you are taking. Do not start or stop taking any medicines before checking with your doctor or pharmacist. This includes prescription and nonprescription medicines or remedies. Remember, VIAGRA should never be used with medicines that contain nitrates (see *VIAGRA Is Not for Everyone*). If you are taking a protease inhibitor, your dose may be adjusted (please see *Finding the Right Dose for You.*) VIAGRA should not be used with any other medical treatments that cause erections. These treatments include pills, medicines that are injected or inserted into the penis, implants or vacuum pumps.

Finding the Right Dose for You

VIAGRA comes in different doses (25 mg, 50 mg and 100 mg). If you do not get the results you expect, talk with your doctor. You and your doctor can determine the dose that works best for you.

- Do not take more VIAGRA than your doctor prescribes.
- If you think you need a larger dose of VIAGRA, check with your doctor.
- VIAGRA should not be taken more than once a day.

If you are older than age 65, or have serious liver or kidney problems, your doctor may start you at the lowest dose (25 mg) of VIAGRA. If you are taking protease inhibitors, such as for the treatment of HIV, your doctor may recommend a 25 mg dose and may limit you to a maximum single dose of 25 mg of VIAGRA in a 48 hour period.

How To Take VIAGRA

Take VIAGRA about one hour before you plan to have sex. Beginning in about 30 minutes and for up to 4 hours, VIAGRA can help you get an erection if you are sexually excited. If you take VIAGRA after a high-fat meal (such as a cheeseburger and french fries), the medicine may take a little longer to start working. VIAGRA can help you get an erection when you are sexually excited. You will not get an erection just by taking the pill.

Possible Side Effects

Like all medicines, VIAGRA can cause some side effects. These effects are usually mild to moderate and usually don't last longer than a few hours. Some of these side effects are more likely to occur with higher doses. The most common side effects of VIAGRA are headache, flushing of the face, and upset stomach. Less common side effects that may occur are temporary changes in color vision (such as trouble telling the difference between blue and green objects or having a blue color tinge to them), eyes being more sensitive to light, or blurred vision.

In rare instances, men have reported an erection that lasts many hours. You should call a doctor immediately if you ever have an erection that lasts more than 4 hours. If not treated right away, permanent damage to your penis could occur (see *How Sex Affects the Body*).

Heart attack, stroke, irregular heart beats, and death have been reported rarely in men taking VIAGRA. Most, but not all, of these men had heart problems before taking this medicine. It is not possible to determine whether these events were directly related to VIAGRA.

VIAGRA may cause other side effects besides those listed on this sheet. If you want more information or develop any side effects or symptoms you are concerned about, call your doctor.

Accidental Overdose

In case of accidental overdose, call your doctor right away.

Storing VIAGRA

Keep VIAGRA out of the reach of children. Keep VIAGRA in its original container. Store at room temperature, 59°-86°F (15°-30°C).

For More Information on VIAGRA

VIAGRA is a prescription medicine used to treat erectile dysfunction. Only your doctor can decide if it is right for you. This sheet is only a summary. If you have any questions or want more information about VIAGRA, talk with your doctor or pharmacist, visit www.viagra.com, or call 1-888-4VIAGRA.

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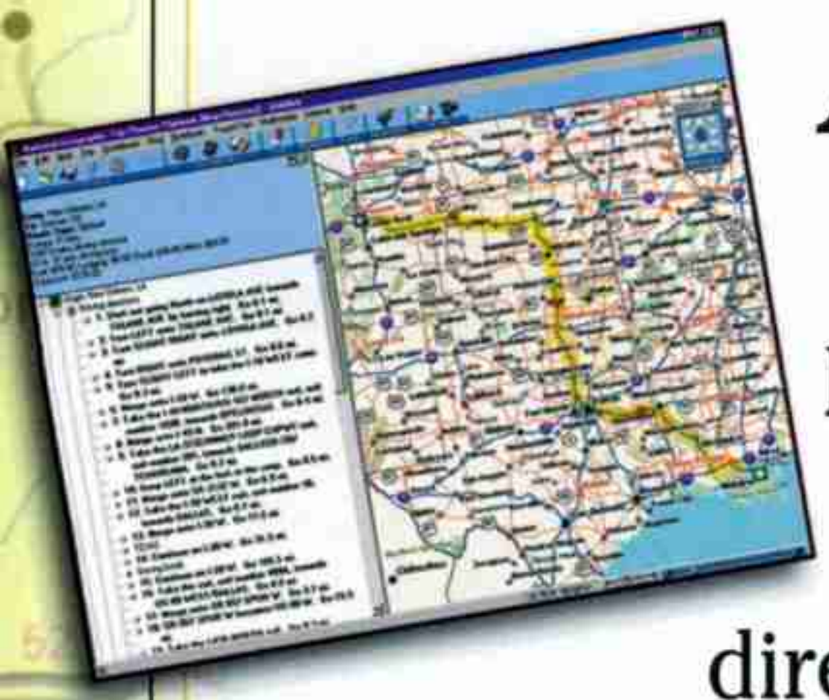
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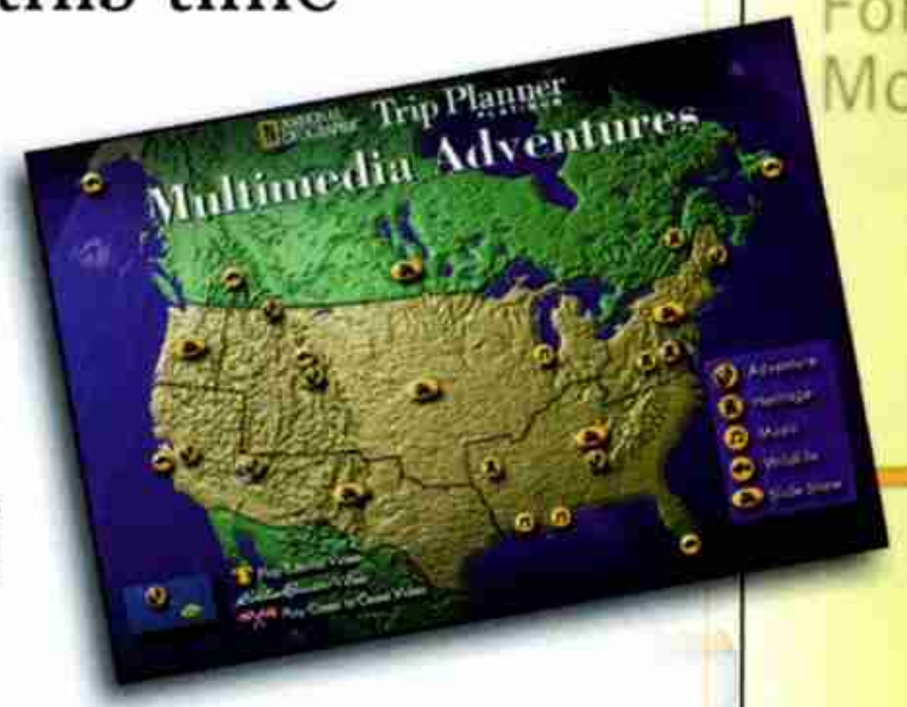
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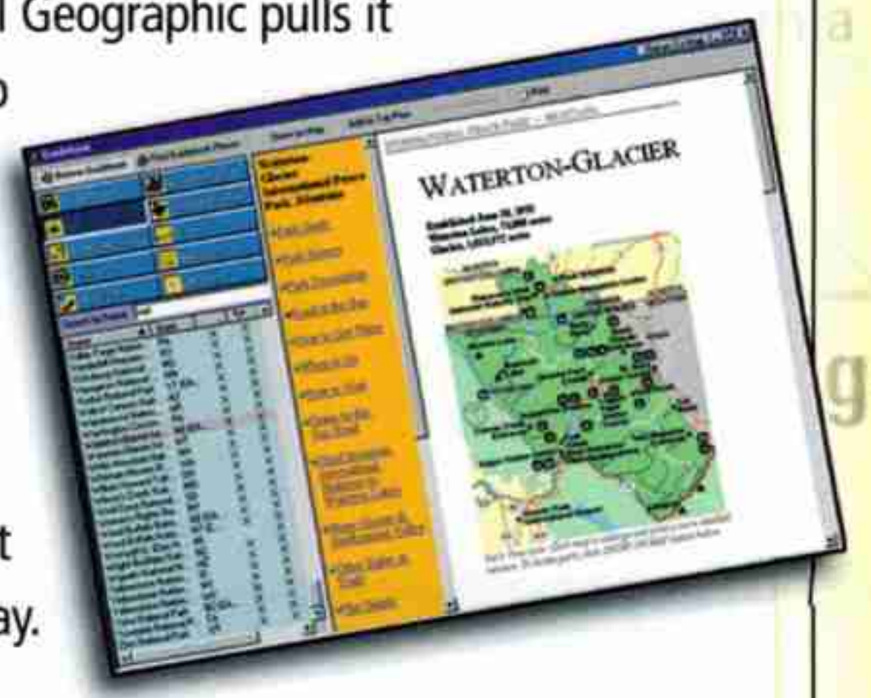
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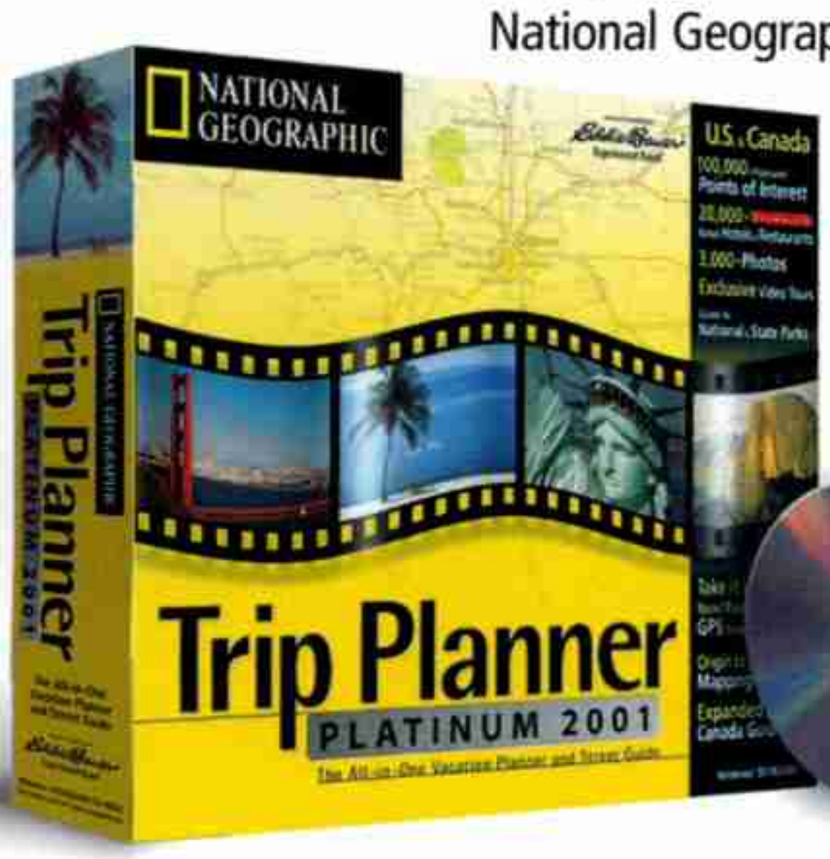




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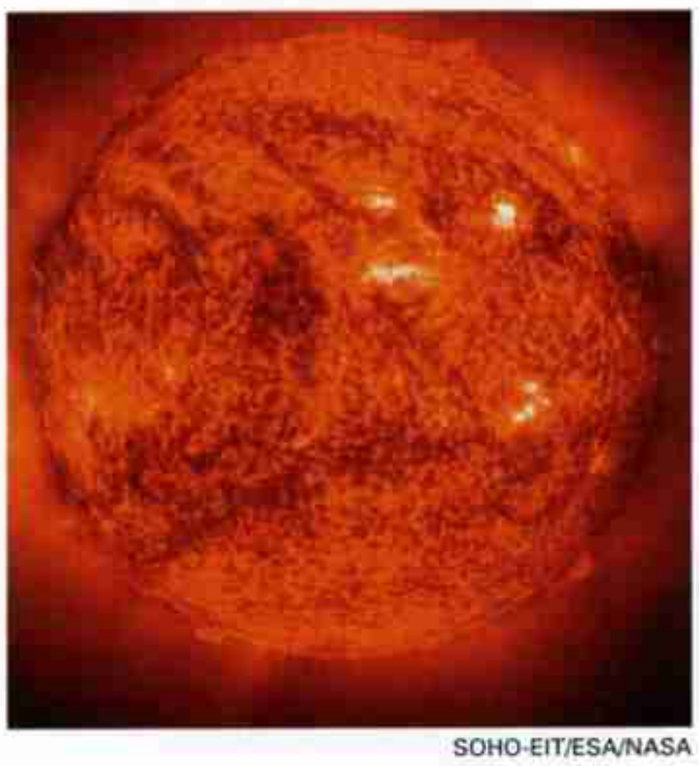
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Everest's Weather: More of the Same?

The forecast for the roof of the world seems predictable: cold. But how cold? To find out, mountaineers put weather probes just below the summit of Mount Everest (whose shadow is shown here) in May 1998 and 1999. Buried in snow, the wind-speed sensors were rendered useless, but other sensors transmitted data to two satellites passing overhead six times a day. Temperatures, which could be read as low as minus 40°F, dipped only to minus 22°F. The probes' batteries gave out before the coldest winter temperatures could be measured.

WALLY BERG



SOHO-EIT/ESA/NASA

An Active Sun Nears Solar Max

A large number of sunspots, hidden beneath the white flashes in this ultraviolet image (left) captured by the SOHO satellite in January, indicates that the sun is at or near the height of its 11-year cycle of activity. The sunspots, signs of powerful shifts in our star's magnetic field, intensify the heating of the sun's corona, increasing the amount of radiation emitted by the sun. At solar maximum the sun can blast a billion tons of matter into the solar system at speeds of more than a million miles an hour. Such bursts trigger geomagnetic storms that, if strong enough, may increase the size and geographic range of auroras and disrupt the operation of communications satellites and electrical power systems on Earth.

Bridge to the Past

This London Bridge fell down a lot earlier than the one in the nursery rhyme. Today all that's left of the structure, built about 1500 B.C., is oak footings as large as two feet in diameter stretching at least a third of the way across the River Thames, near where Parliament now stands. The bridge may have led to a now vanished island, says Fiona Haughey of University College, London. Building it required great effort, suggesting that the London area was the site of a major settlement more than a thousand years earlier than previously believed.

STEVE PATRICIA

TEXT BY BORIS WEINTRAUB

Forum

Letters responding to our February issue were a forceful reminder that "You can't please all of the people all of the time." Nearly 300 readers reacted to the Balkans coverage, some complaining that we "slandered" the Serbs, others that we printed "Serbian propaganda." Some said we misrepresented the Croatians, others accused us of being anti-Albanian, while still others said we portrayed Albanians in a rosy light. We hope many readers agree with our favorite respondent: "It was refreshing to read a just-the-facts report."

Black Dragon River

The story on the Black Dragon River embodies a paradox of our time. Although we feel desolate at the bleak Russian towns and impressed by the economic success across the river in Heihe, it's essential to recognize that environmental degradation and pollution are flowing from the "viable economy."

SUE LILY
Cave Junction, Oregon

Beaverton, Oregon, has been a sister city of Birobidzhan, Russia, for ten years. When I visited a few years ago, I experienced the taunting of the Jews by the non-Jewish population. My friends and I were surrounded and verbally assaulted by young toughs. By their silence the older population in attendance almost encouraged these actions. I can understand why so many Jewish people have left Birobidzhan.

ROSEMARY EGAN
Beaverton, Oregon

Author Simon Winchester has taken us on a journey as bizarre and rich as only our imagination could take us. This one article justifies my yearly renewal.

MARIANO MAZAL
Bear, Delaware

The Rise of Life on Earth

Not only do the incredible fossils of Messel provide a unique glimpse of life 49 million years ago, but they also offer humbling insight about our world today. To witness the ancient fossilized snapshots helps put in perspective the daunting scope of our world and our place in it.

DAN HOLM
Burbank, California

Albanians: A People Undone

After finishing your piece, I feel that I can finally understand the complexity of this dire situation—something I have not been able to do in years of watching TV and reading the papers. Alexandra Boulat's chilling photos made me feel the terror of



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ethnic hate and prejudice, and Priit Vesilind's ability to convey the hopelessness yet inner strength of an entire people is brilliant.

JIM GOESER
Scandinavia, Wisconsin

Your coverage is unconscionably simplistic. It stereotypes all Albanians as naive, innocent victims surrounded by evil forces on all sides. The article grossly misrepresents other groups in the region, particularly the people of neighboring Macedonia.

RICHARD GAUGHRAN
Skopje, Macedonia

Your article demonizes the whole Serbian nation, without distinguishing between innocent civilian and criminal elements. However, the article separates the KLA terrorists, drug dealers, and other criminals from the Albanian population at large. According to some reports, since KFOR troops moved into the region, possibly 300,000 non-Albanians have fled Kosovo and Metohija. Are readers to understand that no damage or tragedy was inflicted on the Serbs?

SNEZANA VITOROVICH
President, Association of Serbian Women
Toronto, Ontario

Eyewitness Kosovo

I, too, was an eyewitness in Kosovo. I served as part of the U.S. contingent of the NATO peacekeeping force last summer. I saw firsthand the devastation the Serbs had wrought on Kosovo—the burned houses, destroyed machinery, and graves. I saw the heartfelt thanks we were given by the returning Kosovar refugees. Then, as the summer wore on, I saw the shoe on the other foot. I saw these same Kosovar Albanians turn around and attack their Serb neighbors with a vengeance. They burned Serb homes and shot local Serbs by night. They blew up Serb Orthodox churches, defaced and tore down Serb historical monuments, and even desecrated Serb cemeteries. The senseless tragedy that I saw convinced me that there are no "innocent victims" in the Balkans—save, perhaps, the children, and even they quickly learn to hate when they are so taught.

GEOFFREY R. WALDEN
Schweinfurt, Germany

Thanks for the wake-up call from Alexandra Boulat's startling photographs from Kosovo. Too often we become complacent about happenings on the other side of the world. God bless Ms. Boulat for having the guts to tell the story.

PETE MELKERT
Brantford, Ontario

As a 13-year-old NATIONAL GEOGRAPHIC reader I find that many of the photos in your article are not at all in good taste. Do you really have to print a photo of a lot of dead people lying on the ground to explain the horror of the situation?

BEN THOMSON
Killingworth, Connecticut

The Balkans/Refugees Map

Croatia was not Axis aligned during World War II, as you state, or at least the majority of the population wasn't. The majority of Croats joined the resistance at its very beginning, along with the Serbian population. The government was Axis aligned, but that government wasn't chosen by the people, nor did it represent the opinions of the Croatian people. But then again, maybe I wasn't taught the true history at school. In the Balkans every nation has its own version of history.

MLADEN MARAVIC
Zagreb, Croatia

Using solid colors to depict ethnic groups that make up more than 50 percent of the population in their region—without defining the size of a region and without shading for different levels of percentages—creates a monolithic visual impression that belies the ethnolinguistic complexities of the area. The result is oversimplification to the point of inaccuracy.

VICTOR A. FRIEDMAN
Chair, Department of Slavic Languages and Literatures
University of Chicago
Chicago, Illinois

You point out that there are 229,000 refugees in Armenia but ignore the many displaced persons who exist in pitiful circumstances in neighboring Azerbaijan. With one million displaced persons in a population of seven million, Azerbaijan endures one of the worst refugee/displaced person tragedies in the world.

DAVID PRITCHARD
Anchorage, Alaska

Central Africa's Orphan Gorillas

Good thing Michael McRae remembered his gorilla manners and "bowed submissively" to the 275-pound gorilla (page 95). I did not and was sorry. In 1991 I went trekking in Rwanda to see mountain gorillas. Covered in sweat and nettle rash, exhausted from hours of climbing, I suddenly came upon a group of gorillas just a few feet in front of me. In a rare moment of awe I forgot the cardinal rule of gorilla etiquette: Don't stare! But stare I did, for at least two seconds, whereupon the silverback male gorilla got up, beat his chest, displayed an impressive set of teeth, and pushed me away. I lost my balance and fell down but was unhurt. It was just a friendly reminder to watch my manners.

BERNADETTE KAYE
Ottawa, Ontario

Selma to Montgomery

Those traveling down the civil rights path have come a long way, but there remains a long distance to go. As a freelance journalist I attended the memorial service at an African-American church for James Earl Ray, alleged assassin of the Rev. Martin Luther King, Jr. There we were, a seemingly educated crowd overall, paying our respects, and for the most part the African Americans sat on one side, the whites on the opposite side. No sign or

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usher dictated the seating; where one sat that day was his or her own choice. Without question, America and the world are still plagued with racial woes.

MIKE VINSON
McMinnville, Tennessee

I have heard many Europeans criticize how African Americans were treated in America during the 1960s. Yet they fail to open their eyes to what is happening around them now. With countries like Austria electing right-wing populists, we might wonder if we are becoming blind to the real problem of bigotry and the people behind it.

KENNETH MARCH
Nürnberg, Germany

Ancient Greece II

I read with interest your description of the Spartan practice of sending boys away from the family to live in barracks at the age of seven. In 1993 I visited the Pari tribe in Lafon in southern Sudan and learned that one of their customs was to send boys away from their families at the age of seven. The boys then joined their age group on a huge rocky outcrop in the center of their district, where they lived until they married. Perhaps this is another indication of the universality of many human customs.

REG LAWLOR
Dublin, Ireland

Geographica

If your readers would like to see the breathtaking statue of Leonardo da Vinci's horse, they don't have to travel to Milan, Italy. The other casting is in Grand Rapids, Michigan, in a sculpture garden built by art patron Frederik Meijer.

TONY ANASON
Jupiter, Florida

You have a picture of 107-year-old Ora Glass of Omaha, Nebraska, with the headline, "Surpassing the Century Mark." I have known Ora since 1942, when she was baby-sitting and doing housework for a lady in my apartment house. She has been a friend of my family for over 58 years. Her grandmother lived to be over 110; maybe she will too. Thank you for honoring her.

YVONNE RUFF
Holiday Island, Arkansas

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*On*Screen

■ EXPLORER, JUNE 4

Fearsome Frogs

Call it the amphibian that ate Arizona. This June EXPLORER reveals that the common bullfrog (below), introduced into the West a century ago, is now an environmental threat there. With natural predators unable to control its spread, the creature is eating its way across the Grand Canyon State, consuming endangered native fish species as well as snakes, birds, and even other frogs. While arid Arizona is better known for deserts, its man-made waterways have become bullfrog heaven, and scientists are worried. "These are hungry amphibians that lay up to 20,000 eggs a year," says co-producer Brian Breger. "No one knows how to stop them."

■ PROGRAM GUIDE

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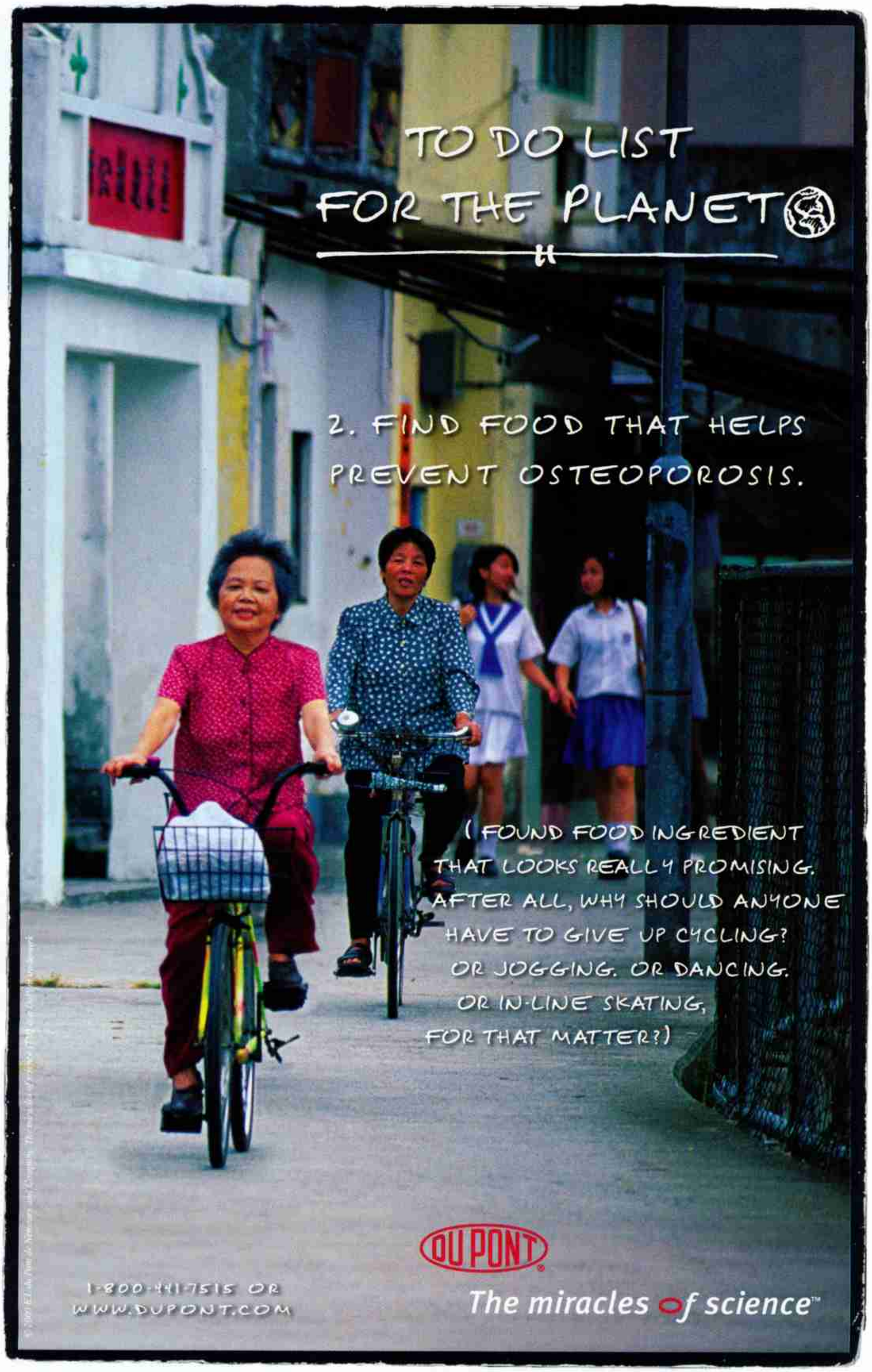
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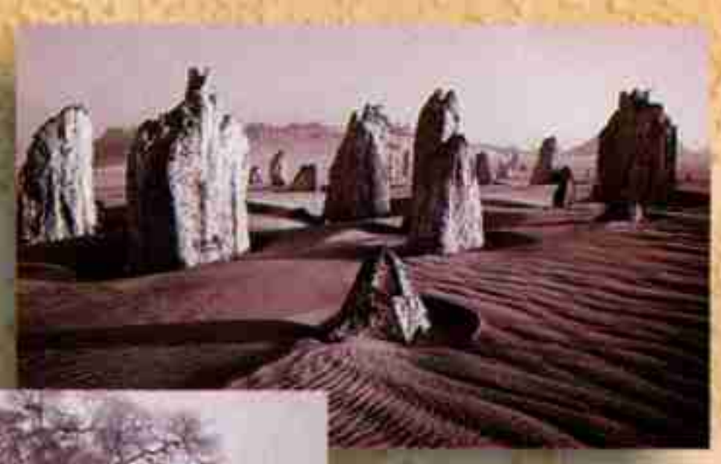
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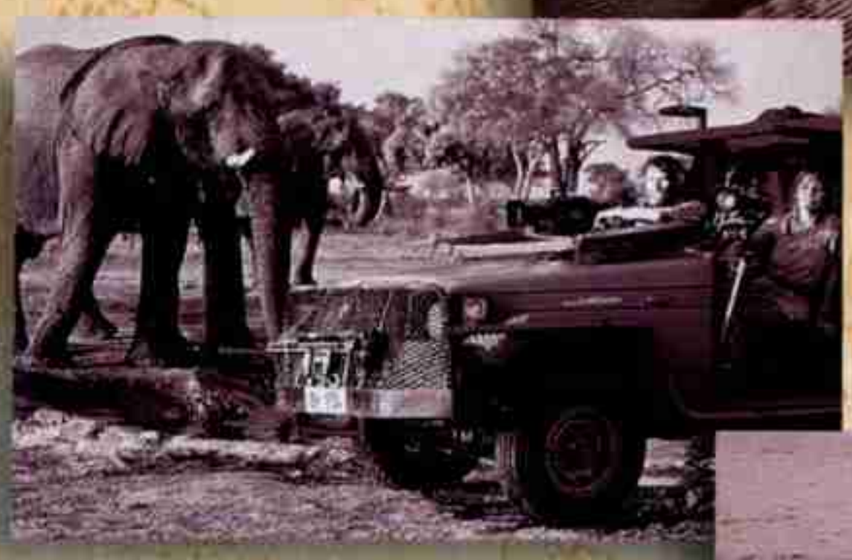
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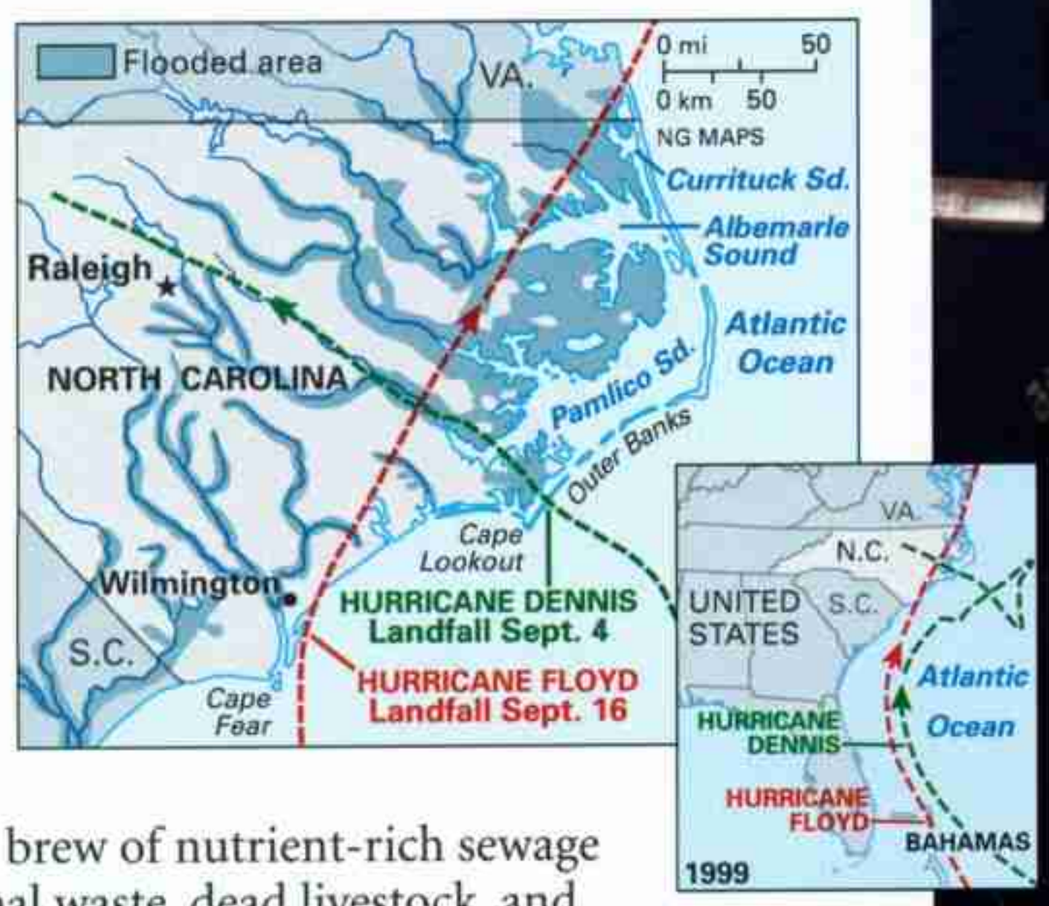
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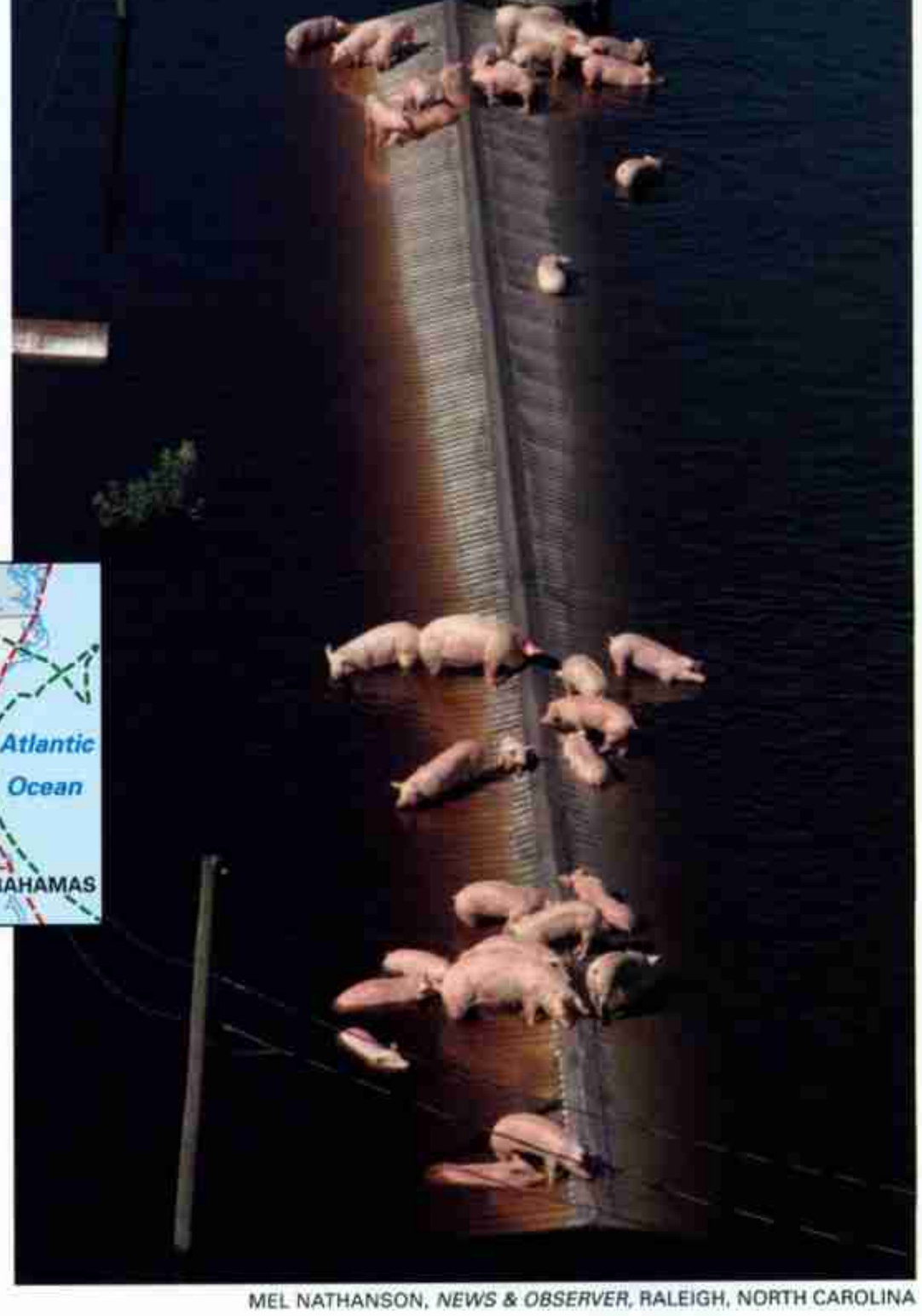
NATIONAL GEOGRAPHIC

Earth Almanac

After the Deluge, More Trouble?

Misery abounded last September in North Carolina, where hogs awaited rescue on a barn roof. Two hurricanes, Dennis and Floyd, inundated the state's coast with upwards of two feet of rain, drowning more than three million chickens, turkeys, and hogs. And another disaster may follow.



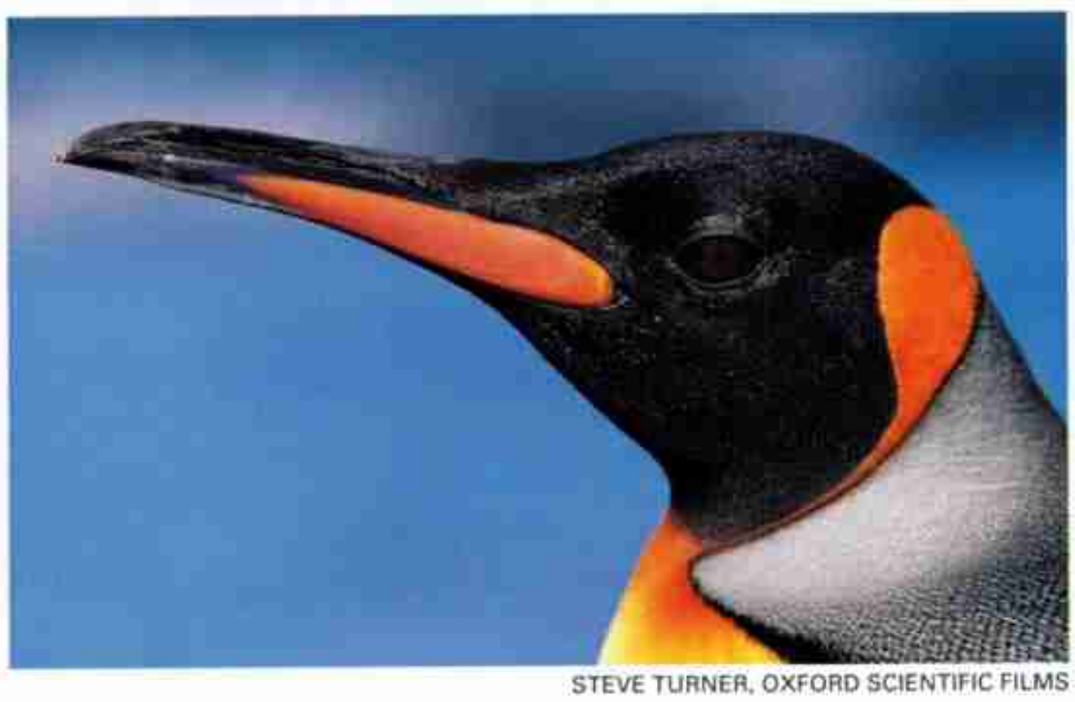


MEL NATHANSON, *NEWS & OBSERVER*, RALEIGH, NORTH CAROLINA

A witch's brew of nutrient-rich sewage and animal waste, dead livestock, and topsoil surged from coastal rivers to the Outer Banks. Estuaries were carpeted with tons of organic matter, endangering this rich fishery of crabs, shrimps, oysters, menhaden, bluefish, and croakers.

Usually the area's brackish estuaries are well mixed top to bottom. But in the hurricanes' aftermath, says Larry Crowder, a Duke University marine ecologist, "the top 18 feet of Pamlico Sound was all fresh water—80 to 85 percent of the volume." This layer of floodwater prevented oxygen from reaching lower, saltwater levels.

Crowder warns that spring warming could cause the tons of nutrients to spawn algae blooms, depleting oxygen even more and suffocating aquatic life. "Heavy spring rains would further reduce oxygen," he adds.



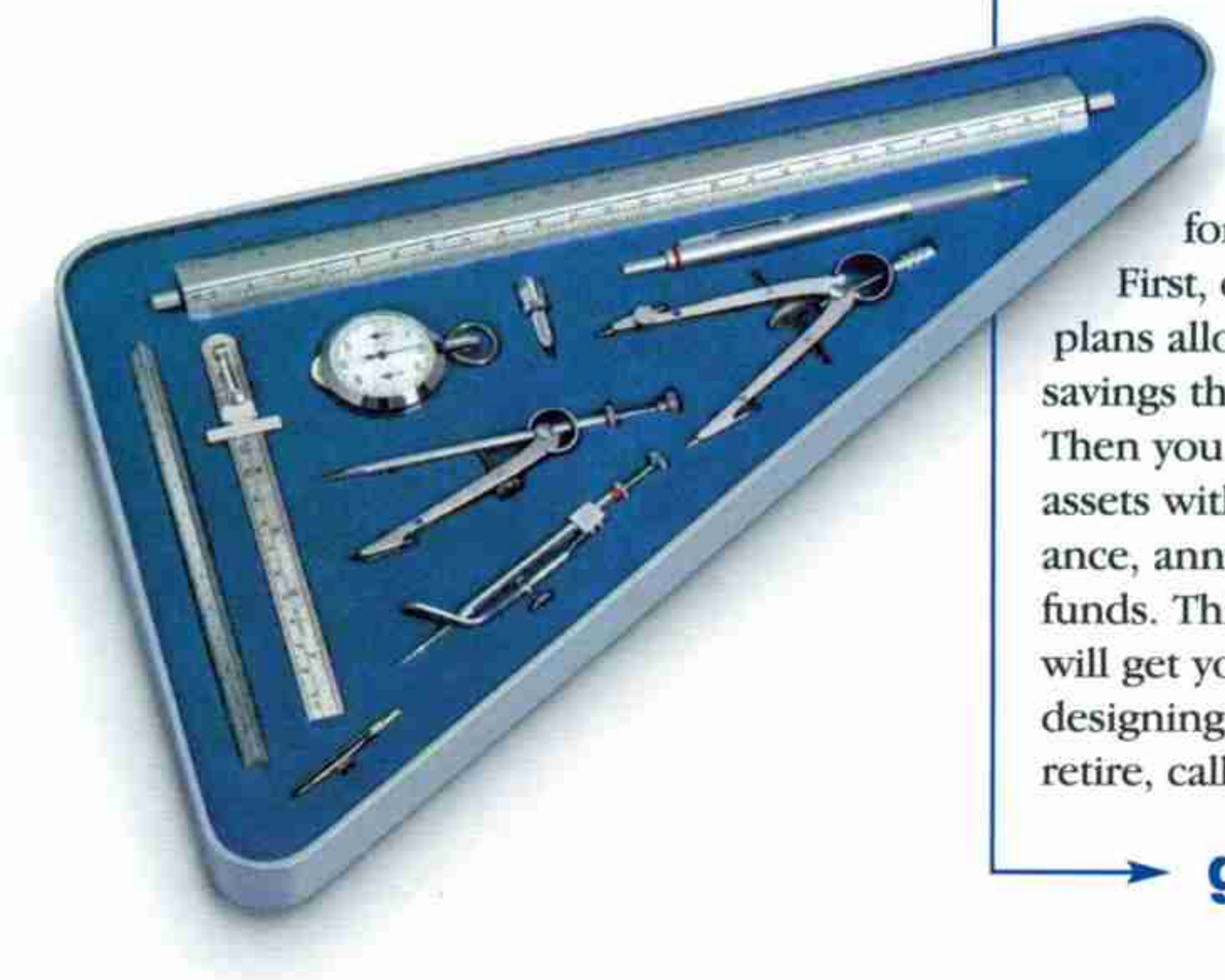
STEVE TURNER, OXFORD SCIENTIFIC FILMS

King Penguin Eyes: Very Shifty

King penguins nest on land, where sunlight can be dazzling, and feed in dim sea depths down to 900 feet. How do their eyes adjust? The pupils expand and contract over an extremely wide range of sizes, says Graham Martin of the University of Birmingham in England, who studied the birds off South Georgia. In sunlight the pupils shrink to pinholes. But when the birds dive, the pupils quickly widen to half an inch, with 300 times the area. Thus they can spot their prey, small bioluminescent fish.

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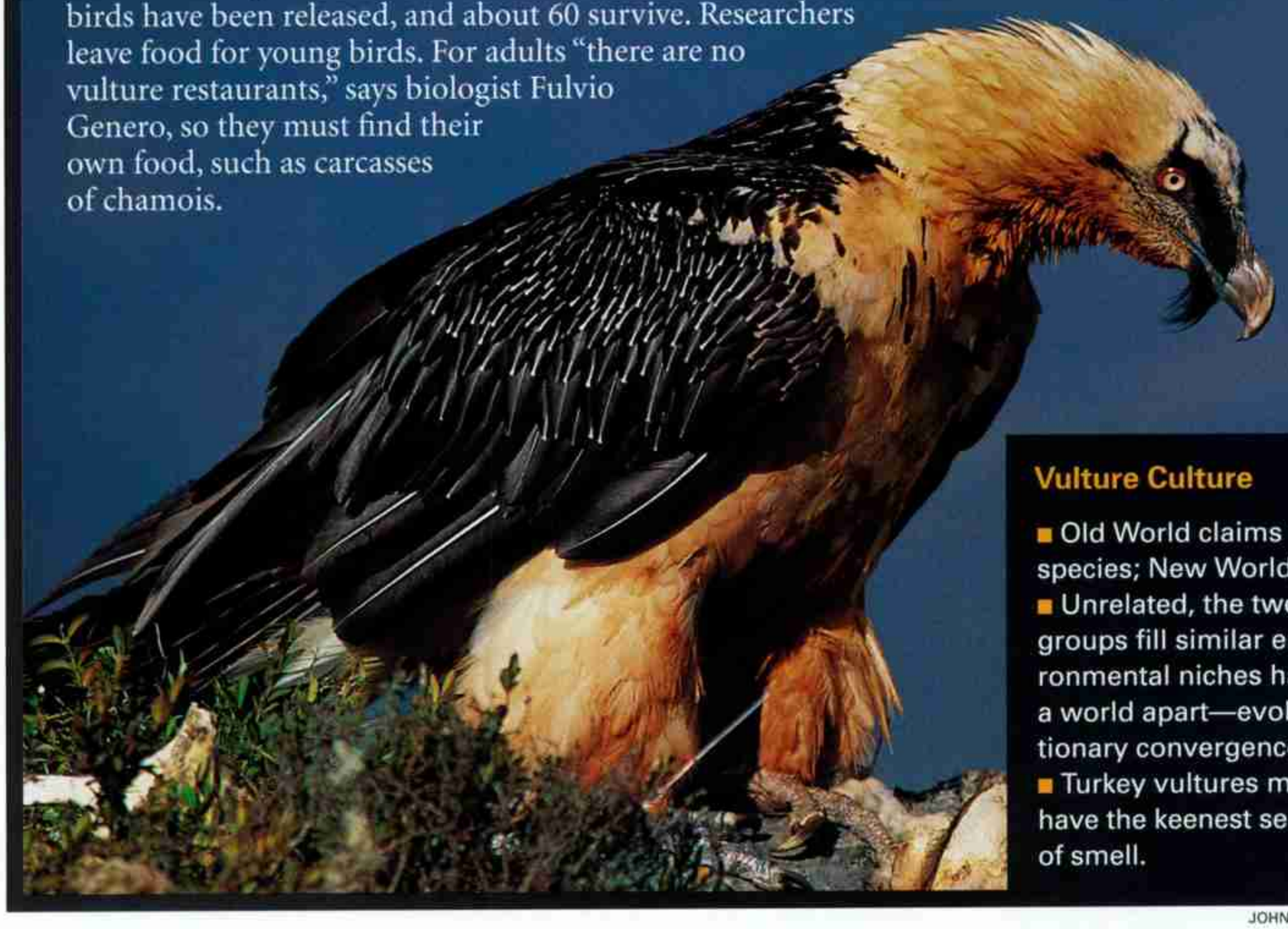
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Bearded Vultures Return to the Alps

Hunted nearly to extinction in Europe, the continent's largest birds are again patrolling Alpine peaks on nine-foot wingspans. Farmers long reviled them as *lammergeiers*—lamb vultures. In truth, bearded vultures' main fare is dead animal bones. Since 1986, 88 captive-raised birds have been released, and about 60 survive. Researchers leave food for young birds. For adults "there are no vulture restaurants," says biologist Fulvio Genero, so they must find their own food, such as carcasses of chamois.



Vulture Culture

- Old World claims 15 species; New World, 7.
- Unrelated, the two groups fill similar environmental niches half a world apart—evolutionary convergence.
- Turkey vultures may have the keenest sense of smell.

JOHN CANCALOSI

■ NGS RESEARCH GRANT

Caterpillar's Nest Is Its Castle





Madrone caterpillars don't get out much. They're stay-at-homes—except when they leave to feed in the dead of night. In Mexico's Sierra Madre Occidental they weave a silk nest so tight that it can hold water. As many as several hundred caterpillars spend ten months inside, then emerge as butterflies.

The caterpillars feed only on the leaves of their home and namesake tree, the madrona (left)—and shun the light, even avoiding moonlight. Biologists Terrence Fitzgerald and Dessie Underwood use an infrared beam to record them foraging along chemical-laced silk trails (above). They do so through winter in very low temperatures, sometimes freezing to death: "They push the limits," Fitzgerald says.

BOTH BY TERRENCE D. FITZGERALD



Photographed by Elio Della Ferrera

WILDLIFE AS CANON SEES IT

Winds whip across a plateau high in the Ethiopian mountains as a band of gelada baboons settles into a day of grazing. A specialized grass-eater, the gelada diligently accumulates clumps of grass in its hands, plucking each blade with thumb and forefinger, always while seated. Bands can number in the hundreds, and their extensive repertoire of vocal and visual communications make for noisy and active groups. The baboons never stray far from the escarpment edges, retreating at night to sleep on the steep precipices. Gelada baboons are at risk from agricultural expansion into their already restricted geographical range.

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Gelada Baboon *(Theropithecus gelada)*
Size: Length of head and body, (male) 68-75 cm, tail 45-55 cm; (female) 50-65 cm, tail, 32-50 cm
Weight: Average male 20 kg; female 13 kg
Habitat: Montane grasslands and gorges above 2,000 m in the central highlands of Ethiopia
Surviving number: Estimated at 4,000-7,000 in Simen Mountains National Park; no current estimates elsewhere

NATURE
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■ NGS RESEARCH GRANT

Clever Swifts Make Living Nests

"Phantoms in the sky," Manuel Marín dubs swallow-like birds called swifts. An ornithologist with the Natural History Museum of Los Angeles County, Marín studies these aerial acrobats in Costa Rica. Most intriguing to him are five species—including this chestnut-collared swift (right)—with unusual nestmaking habits. The birds live behind waterfalls, presenting a climbing challenge for Marín and his research team (above). The swifts make nests out of moss, other plants, and mud, positioning them in rock crevices. The falls' spray nurtures the plants, which grow into the rock. "I have records of a nest that swifts have been using for at least 14 years," says Marín.



BOTH BY MANUEL MARÍN



ANDREW A. BRYANT

Perilous Future for Rare Marmots

One of the world's most endangered mammals, Vancouver Island marmots live only in subalpine meadows on that island. Last year researchers could find only 62. So serious is their plight that 27 have been taken to captive-breeding programs in Calgary and Toronto zoos. Clear-cut logging is the problem—but only indirectly, says Andrew Bryant, chief scientist of the Marmot Recovery Foundation. "Marmots like to colonize clear-cuts," he explains, "but then after a couple of years the clear-cuts don't provide enough of the right grasses and flowers. Plus the marmots are vulnerable to predators." Bryant and his team hope to reestablish 400 to 600 marmots on three separate sites.

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BOTH BY RICHARD ARONSON

■ NGS RESEARCH GRANT

Coral Die-off in Belize—A Core Issue

Reefs go through periods of stability and change, and it is often predictable which coral species will take over when a dominant species dies. But Richard Aronson of Alabama's Dauphin Island Sea Lab and his colleagues found an unusual scenario off Belize.

Staghorn coral and the closely related elkhorn coral have dominated Caribbean reefs for millennia. But in the past 25 years these corals have disappeared from many reefs, killed by white-band disease. Discovered in the 1970s attacking coral off St. Croix, the malady causes the living exterior to die on the coral skeleton, from base to branch tips.

In Belize, where affected staghorn reefs were reduced to rubble (top) in a single decade, the staghorn was replaced by lettuce coral. Aronson's group wondered whether similar transitions had occurred in the past. So they took 15-foot-long cores (above) that sampled layers as old as 3,800 years. The cores showed no prior staghorn die-offs with lettuce coral moving in.

TEXT BY JOHN L. ELIOT

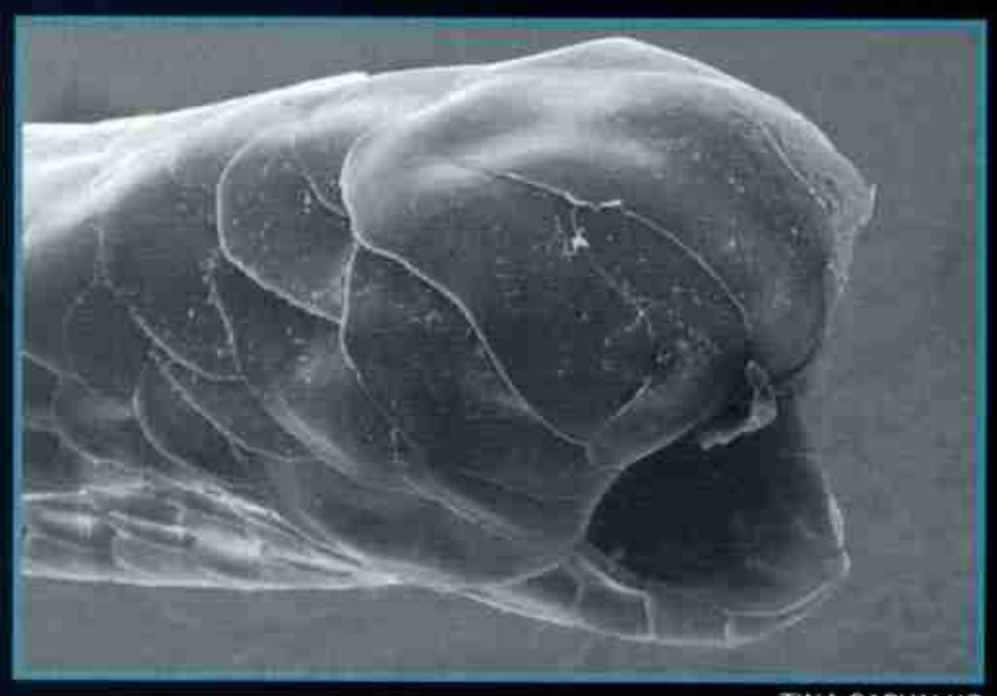


Reef Ecosystem Threats

- Hurricanes, diseases, and warming water, which causes bleaching
- Pollution and sediment from coastal development
- Commercial exploitation of fish, corals, giant clams, and many other species

Hawaii's Only Snake—It's Tiny

Was there a Hawaiian St. Patrick? If so, he didn't drive out the snakes—he never let them in. The lone exception is called a Hawaiian blind snake. It may have arrived in 1930 from the Philippines in soil surrounding potted palm trees replanted at a Honolulu school. Three to eight inches long, the wormlike snakes feed on termites and other insects. Tiny nostrils and a forked tongue are revealed by this scanning electron microscope image.



TINA CARVALHO

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In rare cases, serious stomach problems, such as bleeding, can occur without warning. People with allergic reactions, such as asthma, to aspirin or other arthritis medicines should not take VIOXX.

Tell your doctor if you have liver or kidney problems, or are pregnant. Also, VIOXX should not be used by women in late pregnancy.

VIOXX has been extensively studied in large clinical trials. Commonly reported side effects included upper respiratory infection, diarrhea, nausea and high blood pressure. Report any unusual symptoms to your doctor.

ASK YOUR DOCTOR OR HEALTHCARE PROFESSIONAL ABOUT VIOXX.

Call 1-800-859-5993 for more information, or visit www.vioxx.com. Please see important additional information on the next page.

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You should read this information before you start taking VIOXX*. Also, read the leaflet each time you refill your prescription, in case any information has changed. This leaflet provides only a summary of certain information about VIOXX. Your doctor or pharmacist can give you an additional leaflet that is written for health professionals that contains more complete information. This leaflet does not take the place of careful discussions with your doctor. You and your doctor should discuss VIOXX when you start taking your medicine and at regular checkups.

What is VIOXX?

VIOXX is a nonsteroidal anti-inflammatory drug (NSAID) that is used to reduce pain and inflammation (swelling and soreness). VIOXX is available as a tablet or a liquid that you take by mouth.

VIOXX is a medicine for:
- relief of osteoarthritis (the arthritis caused by age-related "wear and tear" on bones and joints)
- management of acute pain in adults (like the short-term pain you can get after a dental or surgical operation)
- treatment of menstrual pain (pain during women's monthly periods).

Who should not take VIOXX?

Do not take VIOXX if you:
- have had an allergic reaction such as asthma attacks, hives, or swelling of the throat and face to aspirin or other NSAIDs (for example, ibuprofen and naproxen).
- have had an allergic reaction to rofecoxib, which is the active ingredient of VIOXX, or to any of its inactive ingredients. (See Inactive Ingredients at the end of this leaflet.)

What should I tell my doctor before and during treatment with VIOXX?

Tell your doctor if you are:
- pregnant or plan to become pregnant. VIOXX should not be used in late pregnancy because it may harm the fetus.
- breast-feeding or plan to breast-feed. It is not known whether VIOXX is passed through to human breast milk and what its effects could be on a nursing child.

Tell your doctor if you have:
- kidney disease
- liver disease
- heart failure
- high blood pressure
- had an allergic reaction to aspirin or other NSAIDs
- had a serious stomach problem in the past.

Tell your doctor about:
- any other medical problems or allergies you have now or have had.
- all medicines that you are taking or plan to take, even those you can get without a prescription.

Tell your doctor if you develop:
- ulcer or bleeding symptoms (for instance, stomach burning or black stools, which are signs of possible stomach bleeding).
- unexplained weight gain or swelling of the feet and/or legs.
- skin rash or allergic reactions. If you have a severe allergic reaction, get medical help right away.

How should I take VIOXX?

VIOXX should be taken once a day. Your doctor will decide what dose of VIOXX you should take and how long you should take it. You may take VIOXX with or without food.

Can I take VIOXX with other medicines?

Tell your doctor about all of the other medicines you are taking or plan to take while you are on VIOXX, even other medicines that you can get without a prescription. Your doctor may want to check that your medicines are working properly together if you are taking other medicines such as:
- methotrexate (a medicine used to suppress the immune system)
- warfarin (a blood thinner)
- rifampin (an antibiotic)
- ACE inhibitors (medicines used for high blood pressure and heart failure).

What are the possible side effects of VIOXX?

Serious but rare side effects that have been reported in patients taking VIOXX and/or related medicines have included:

- Serious stomach problems, such as stomach and intestinal bleeding, can occur with or without warning symptoms. These problems, if severe, could lead to hospitalization or death. Although this happens rarely, you should watch for signs that you may have this serious side effect and tell your doctor right away.
- Serious kidney problems occur rarely in patients taking NSAIDs.
- Severe liver problems occur rarely in patients taking NSAIDs. Tell your doctor if you develop symptoms of liver problems. These include nausea, tiredness, itching, tenderness in the right upper abdomen, and flu-like symptoms.

More common, but less serious side effects reported with VIOXX have included the following:

Upper and/or lower respiratory infection and/or inflammation
Headache
Dizziness
Diarrhea
Nausea and/or vomiting
Heartburn, stomach pain and upset
Swelling of the legs and/or feet
High blood pressure
Back pain
Tiredness
Urinary tract infection.

These side effects were reported in at least 2% of osteoarthritis patients receiving daily doses of VIOXX 12.5 mg to 25 mg in clinical studies.

The side effects described above do not include all of the side effects reported with VIOXX. Do not rely on this leaflet alone for information about side effects. Your doctor or pharmacist can discuss with you a more complete list of side effects. Any time you have a medical problem you think may be related to VIOXX, talk to your doctor.

What else can I do to help manage my osteoarthritis pain?

Talk to your doctor about:
- Exercise
- Controlling your weight
- Hot and cold treatments
- Using support devices.

What else should I know about VIOXX?

This leaflet provides a summary of certain information about VIOXX. If you have any questions or concerns about VIOXX, osteoarthritis or pain, talk to your health professional. Your pharmacist can give you an additional leaflet that is written for health professionals.

Do not share VIOXX with anyone else; it was prescribed only for you. It should be taken only for the condition for which it was prescribed.

Keep VIOXX and all medicines out of the reach of children.

Inactive Ingredients:

Oral suspension: citric acid (monohydrate), sodium citrate (dihydrate), sorbitol solution, strawberry flavor, xanthan gum, sodium methylparaben, sodium propylparaben.

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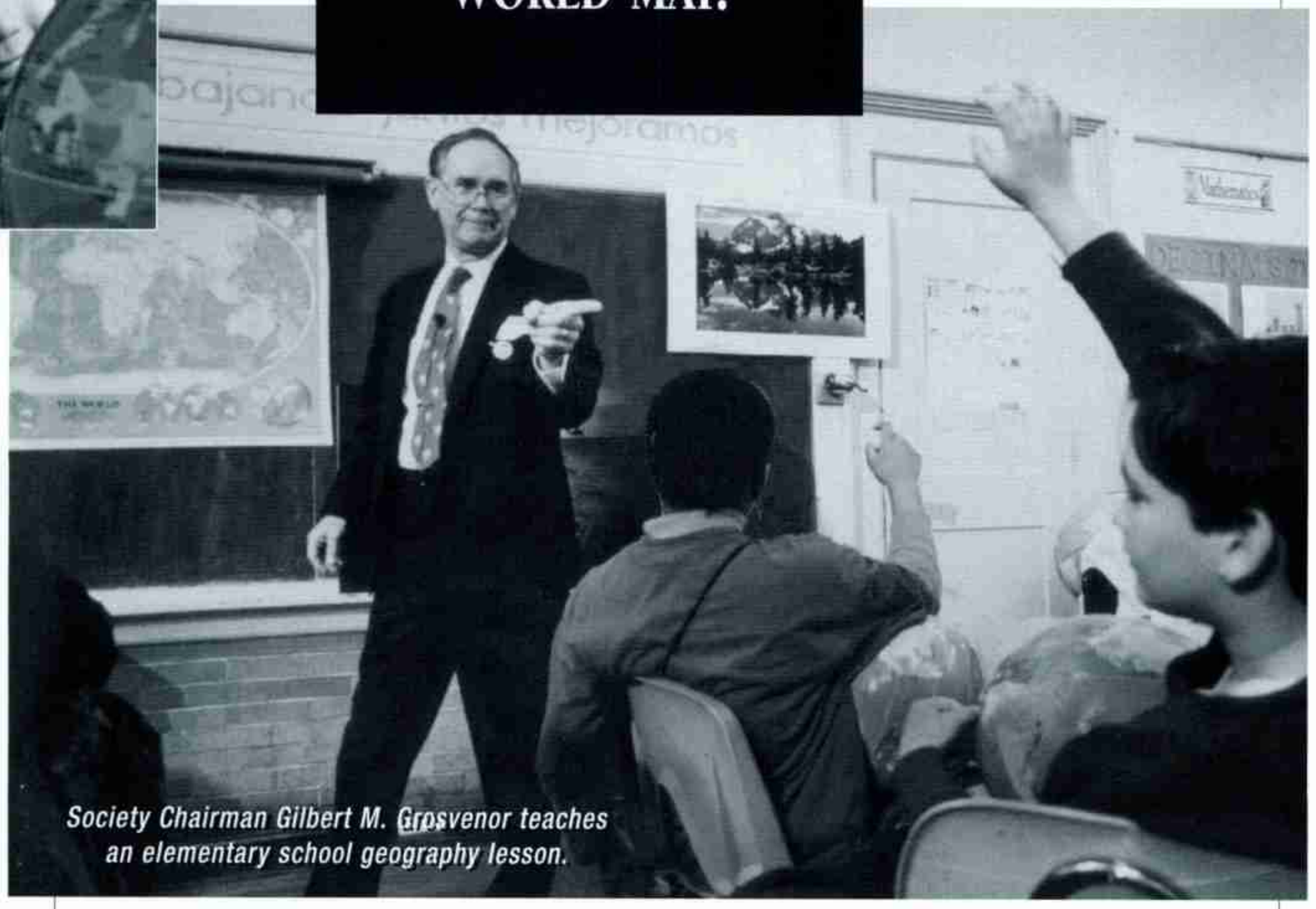
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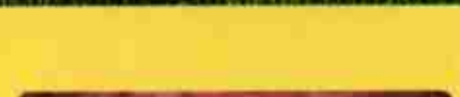
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NATIONAL GEOGRAPHIC



HEATHER R. HOFFMAN, NGS STAFF

From the Editor

SAY CHEESE! For one fleeting moment during our annual photographic seminar in Washington, D.C., we managed to corral more than half the photographers who shoot for the GEOGRAPHIC on a regular basis. The 47 men and women shown here have collectively logged some 700 years taking pictures for this magazine alone. They've photographed roughly 715 articles, and at a current average of 29,000 frames shot per story, that works out to about 20.7 million images. I cannot imagine a more diverse set of characters. Some embody the role of devil-may-care globe-trotter; others would fit right in at a PTA meeting. Immersing themselves in exotic cultures or dodging bullets on the battlefield, they capture the essence of our shared humanity. Together with Director of Photography Kent Kobersteen and Assistant Director Susan Smith (standing with me in front), they are responsible for the photographic excellence that is this magazine's hallmark.

Bill Allen

Sublime and ridiculous collide at London's exclusive Hurlingham Club, where revelers drive "dodgems" after viewing antique Bentleys and other revered models at the Louis Vuitton Classic car show. Giddy as a reborn Scrooge, London thrives as a leader in global finance, culture, and even (gasp) cuisine.

LON

By **SIMON WORRALL** Photographs by **JODI COBB**
NATIONAL GEOGRAPHIC PHOTOGRAPHER

Cleo on a Roll



Ring in the new



Audible icons of old and new, the stately toll of Big Ben competes with the bleat of cellular phones on Westminster Bridge near Parliament. A third of all Londoners own "mobiles," which now rival umbrellas as the item most often lost by commuters.

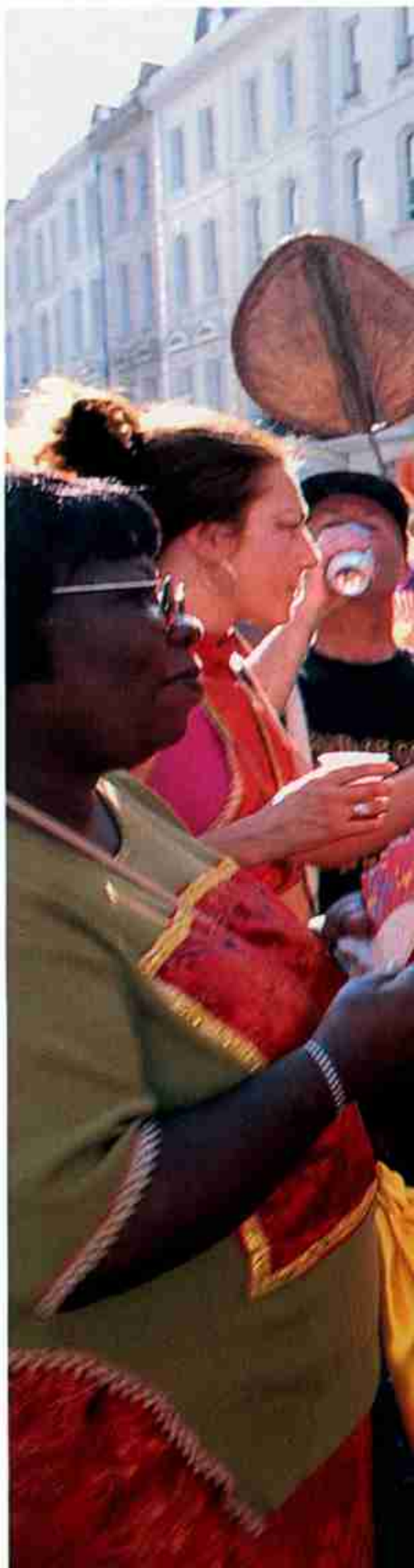
When you arrive here,

"I THINK IT'S ONE of Richard's," said Norman Foster, as he banked his white JetRanger helicopter over the Albert Bridge and began to rip eastward along the Thames toward Greenwich. A thousand feet below us was a new riverside residential complex, which from the air looked like a Maya pyramid. Ahead of me Foster's well-polished pate gleamed in the sun. The rivalry between the dueling knights of British architecture, Norman Foster and Richard Rogers, is well known. When Rogers was ennobled in 1998, he chose the title Lord Rogers of Riverside. When a similar honor was bestowed on Foster last year, he went for Lord Foster of Thames Bank. But when I asked the name of the building below us, Foster reacted with studied vagueness, as though the other man's creation was not even significant enough to have registered on his mental radar screen. "I think it's called Montevetro," he said, gunning the chopper past it. "But I'm not sure."

Now our helicopter was hovering like a dragonfly over what looked like two circular swimming pools: the fountains in Trafalgar Square. As if on cue, a herd of double-decker buses formed into a continuous red stripe around one edge of it. As the helicopter banked again, some of the great architectural set pieces of the past came into view: Buckingham Palace, the Houses of Parliament, the British Museum. Beyond them, stretching 29 miles from north to south, 36 miles from west to east, Europe's greatest city unfolded to the horizon like a giant Lego model laid out on a kitchen table.

Inspired by the millennium and fueled in part by the National Lottery, London is in the middle of a building frenzy. The farther east we flew, the more I began to catch sight of the new buildings that are redefining its skyline. "The brick power station down there is the Tate Gallery's new museum of modern art," shouted Foster through the headphones, swinging us around for a better look at the revitalized area of Bankside. "And over there is the Millennium Bridge, which we are building. It will reconnect London's most historic district, the City, with Bankside."

In a moment Foster was pointing down at a construction site at Canary Wharf, part of the centerpiece of the new Docklands financial district. "That's our new headquarters for the



Fused in sweaty abandon, dancers sway to the beat of soca (a mix of soul and calypso) at the annual Notting Hill Carnival, one of Europe's largest festivals. It was begun in the 1960s by West Indian immigrants in response to area race riots. Today the carnival lures fans from around the globe. The mélange suits this city of seven million, one-quarter of them from ethnic minorities. Says Grenada-born Leo Simon, right, "At carnival you don't feel any of the normal tension."

SIMON WORRALL survived in London during the 1970s by critiquing plays for the Royal Court Theatre and the Royal Shakespeare Company. His writing has appeared in the *New Republic, Die Zeit, Esquire,* and the *Sunday Times* magazine (London), among others. This is his first article for NATIONAL GEOGRAPHIC.

you feel something in the air.

Hongkong and Shanghai Bank." In the distance the Thames began to writhe across the land like a giant anaconda. "And over there," he said, indicating the Royal Naval College at Greenwich, "is what I think is Christopher Wren's greatest building." But I was looking the other way, at a vast, milk white, saucer-shaped disk spread below us like the mother ship of some alien force recently arrived from another galaxy. *One of Richard's*, I scribbled in my notebook, as the shadow of the chopper skimmed over the Millennium Dome.

Invention and integration, the synthesis of old and new, sum up the work of Norman Foster, who is changing the face of London more than any architect since Sir Christopher Wren. They are also watchwords for London, which always manages to preserve the past while reinventing itself for the future. For long periods the city slumbers, then it rouses itself and in a burst of activity enters a period of extraordinary growth and change.

The last time London occupied center stage in world history was the "swinging sixties," when its music and fashion defined the look and sound of a generation. London is calling again. Its theater and music scenes are world leaders; its restored historic buildings and monuments glitter with gold leaf; its immaculate parks look better than ever. Most startling are the changes among its people. The millennium ended in Indonesia and the Balkans with



ethnic cleansing and racial hatred. Londoners are moving in the opposite direction, making their city the world's greatest cosmopolis.

FOR JOHN SHEPHERD, a cabbie who has been threading his way through London's streets for the past 30 years, keeping pace with all this is no small task. "To do the Knowledge now is taking up to three years," he said, recalling the exam that London cab drivers have to take before they can get their license, as we swept over Waterloo Bridge on our way to Peckham in south London, where he was born. "I left school at 15 and started work in the old Covent Garden flower market." A short, well-built man with a domed, balding head, blue-gray eyes, a close mustache, and a razor-sharp wit, John is one of those archetypal Londoners who seem to have stepped straight out of *Mary Poppins* or *EastEnders*.

"An old cabbie once said to me, 'John, my son, if you learn one thing a day while you're doing this job, by the end of your life' "—he paused meaningfully as a gray plaque marking the onetime home of Charlie Chaplin flashed by—" 'your 'ead will be full of rubbish.' "

We pulled up outside a two-story house on Elmington Road. "See the different colored brick?" said John, pointing up at the wall. "That's where it was hit with a German bomb." From Brunswick Park, along the street, we could hear the sound of children playing. "I did the Knowledge in the afternoons while working at the flower market. In those days you had what was called the Blue Book, which had all the different runs in it. You would get a map, and you would study the route, with all the backstreets, and write them down. Then you would go out on your bike and follow the route. The hardest to remember were all the little alleyways and backstreets. We used to call them 'rat runs.' " He paused. "You can't use



London is a "messy and confusing city," writes historian Stephen Inwood. Yet the disheveled grande dame of the Thames is enjoying a building boom unparalleled since recovery from World War II. Fueled by millennium fever and lottery funds, new projects are rejuvenating London, most notably the once derelict South Bank. "You feel all this economic vitality around you," says lawyer Brendan Davis (below). "Everywhere else is just so dull."

most of them now. They're closing them off."

Not closing, exactly; "calming" is the official term. The addition of speed bumps to London's side streets and alleys, many of which date back to medieval times, is one response to growth and traffic congestion. After decades of flight to the suburbs, London's population is expected to rise to 7.7 million during the next 20 years, approaching what it was at the start of World War II. "You've heard of road rage," said John. "Well, there's a lot of that now."

More than London's shifting topography, it is the shifts in the human landscape that bewilder Shepherd. "I feel like a dinosaur sometimes, as though they're just waiting for people like me to die out," he said, as we settled on a bench in Brunswick Park. As a child he had played a game called Knock Down Ginger in the streets and watched barrage balloons floating overhead to ward off the Luftwaffe's planes. Today kids play video games, and the Germans are allies. Gone too is the almost exclusively white community into which he was born. The boys playing soccer in front of us were mostly of Pakistani or West Indian descent. When I asked John what he thought of mixed marriages, he paused and said with a wink, "A robin won't mate with a blackbird, will it?"

Daniel Shepherd, John's 21-year-old son, resembles John. He has the same slightly slanting, blue-gray eyes, prominent ears, and round



face. But his attitudes couldn't be more different. "If I talk to someone, race is not the first thing I notice," he told me during his lunch break at Dorling Kindersley, the publisher, where he was doing a student internship. By coincidence his office is in Covent Garden, a few yards from where his father once worked and met Daniel's mother. "I have loads of friends who are black. I have got a lot of Indian friends at work. I don't see them as colored people. They're just my mates."

THE WHOLE WORLD lives in London. Walk down Oxford Street and you will see Indians and Colombians, Bangladeshis and Ethiopians, Pakistanis and Russians, Melanesians and Malaysians. Fifty nationalities with communities of more than 5,000 make their home in the city, and on any given day 300 languages are spoken. It is estimated that by 2010 the population will be almost 30 percent ethnic minorities, the majority born in the U.K. Most of these Londoners are the children and in some cases the grandchildren of the many thousands who came here from the Caribbean and the Indian subcontinent during the fifties and sixties, after the British Empire imploded.

Annas Ali, a 17-year-old Londoner of Bangladeshi descent, feels deeply rooted in British society. "I have been here all my life," he told me, as we dodged our way through the festive crowds filling Brick Lane in the East End for Baishakhi Mela, the Bangladeshi New Year. The neighborhood is known as Bangla Town. Union Jacks fluttered next to the green-and-red flag of Bangladesh. Indian music echoed off Victorian brick houses. "I was born at Mile End hospital a half mile away and grew up in Hunton Street. My father had a restaurant there."

Bangla Town has seen centuries of immigration. In the 1600s French Huguenots built a church on the corner of Fournier Street and Brick Lane. Later it became a Methodist

London manages to preserve the





PATRICK WARD (BELOW LEFT)

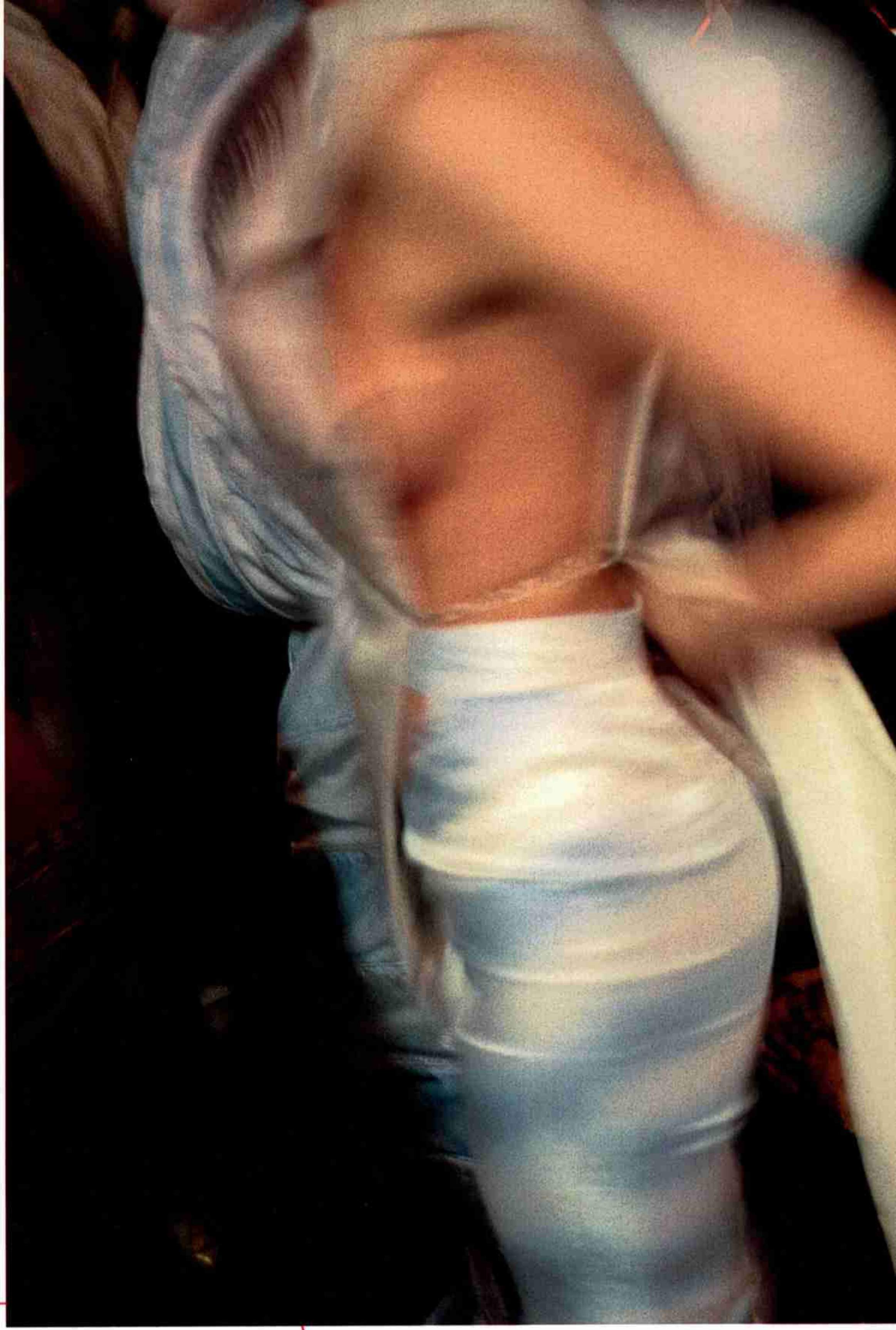
past while reinventing itself for the future.



As if clocking the minutes of a new age, the world's largest observation wheel now spins on the wrist of the Thames. Rising 443 feet, it offers the highest public perch for viewing London's timeless architecture. Views are more traditional from Bank Restaurant (above). But the menu's blend of French, Asian, and "modern British" fare typifies the city's graduation from the overboiled pub grub of the past.

chapel. In the 1890s it was converted into a synagogue. Today it is used by Annas and other Bangladeshis as a mosque. Bangla Town has also had a recent influx from the world of fashion, art, and pop culture. Jarvis Cocker, the lead singer of Pulp, lives nearby. So does Chris Ofili, the young artist of Nigerian descent whose painting "The Holy Virgin Mary," depicting a black Madonna embellished with elephant dung, caused a firestorm of controversy at the Brooklyn Museum of Art last year. Alexander McQueen, the fashion designer, has his workshop on Rivington Street. The result is a fusion of cultures unique to London.

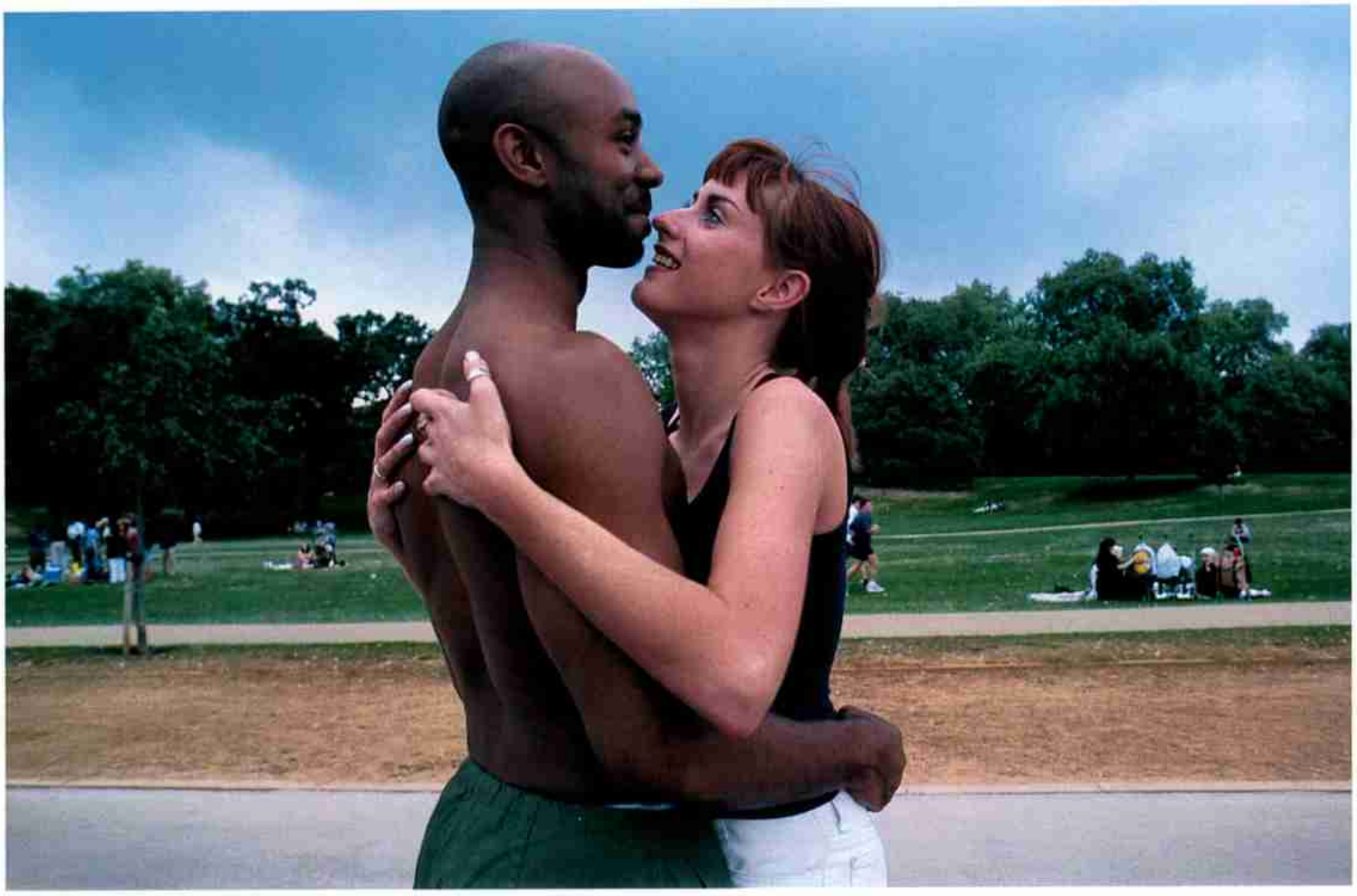
Annas Ali himself is eclectic. With his dark skin, raven black hair, and lustrous brown eyes, he reminded me of Mowgli in the *Jungle Book*. But his hair was cut in the latest London style: short in back, long and slicked back with gel at the front. He is a devout Muslim, an Asian Londoner who talks Cockney English. The gold rings on his fingers were from India, his stylish, midnight blue cardigan—"pure wool," he told me proudly—from Prohibito, a clothes shop on Oxford Street popular among teenagers. "I want to go into fashion," he said. "I want to go to the London School of Fashion."



Mirror, mirror . . .



It's nip and tuck backstage during the influential Graduate Fashion Week as models prepare to parade the eccentric frills of Arkadius. "People come to London for raw excitement," says the Polish-born phenom. "My work is poetic, energetic, shocking."



Embracing the moment, Neil Williams and Joanne Evans enjoy a summer Sunday. "Mixed relationships are more accepted here than in the U.S.," says Evans. Embracing her Indian heritage, London-born Sonia Behl wore a sari to her wedding. A chauffeured Rolls-Royce took her to the ceremony, performed in Sanskrit and English.

Two weeks before I met Annas, a nail bomb went off in Brick Lane—one of three that shook the city last year. The newspapers ran features about neo-Nazi groups with names like Combat 18 and speculated about a coming racial war. But the bombings last year were not part of a broader trend. They were a desperate attempt by a single individual pathologically at odds with his times to stop the racial mixing that, with a typically British lack of hype, has been going on for a generation.

"It's the holy grail of all societies to have the energy that hybridity brings without the distressing divisions," Trevor Phillips told me as we sat in the living room of his house in Stanmore, a leafy suburb on the northern fringes of the city. Born in London of Guyanese origins, Phillips is one of Britain's best known broadcasters and the chairman of the London Arts Board. "We're just reaching for it here. We're just on the edge of being able to do it."

Outside, a Volvo dozed in the driveway. Through a sliding glass door I could see a well-mowed lawn. It was every middle-class Englishman's idea of suburban comfort. What struck me even more was this black Londoner's ease in discussing a subject that in the United States can be fissile material.

"In America you always have to choose: I'm black, or I'm not black," he said. "When I go to New York to visit my sisters, I can, if I so choose, never speak to someone who is not black. Here that is not possible. There are so many different Londons that jostle side by side, and so many different kinds of people who live here, and we have a whole set of manners and ways of looking at people who are different from us that allow us to live right next door to them. To be cool about it."

It is this convivial mixing of the races, not just its diversity, that is so special about London. "There is a great amount of intermarrying here," says Sunand Prasad, an architect of Indian origin whose family emigrated to London 30 years ago. "The races used to be quite distinct, but rather than the edges becoming ever more sharply defined, as they are in France or the States, they are really beginning to blur."


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As the city gets richer, the poor

Along with its cosmopolitanism and tolerance, London's surging economy is drawing a new wave of migrants—not from the Caribbean or Africa but from across the Channel. "London is very attractive to French people at the moment," said Christophe Beauvilain, a 32-year-old executive at Goldman Sachs, as we rushed across the fields of Picardy on Eurostar, the high-speed rail link between Paris and London. It was Sunday night, and the train was packed with French returning to London after a weekend at home. "It is much more dynamic in terms of fashion or night life. And it's more entrepreneurial. All the headquarters of the big financial institutions are here. You make more money. The taxes are lower."

Since the 16th century London's financial district, known as the City or the Square Mile, has been one of the most powerful business centers in the world. Today, with 539 foreign banks, it is the most international: More than 437 billion dollars flows through its foreign currency markets every day, far more than anywhere else in the world. The value of London's economy—$162 billion—is larger than that of many countries, including Poland, Singapore, and even Switzerland.

Pinstripes and polish mark Leadenhall Market in the City, London's square-mile financial district and the world's largest hub of international banking. "City men can afford the luxury of a shine," says Kathryn Ford (right). Life is less glossy for scores of youths who "sleep rough" on the streets, where crime and drug use are rising. Says outreach worker Steve Marshall (above, at far right), "They're in a very vulnerable position."



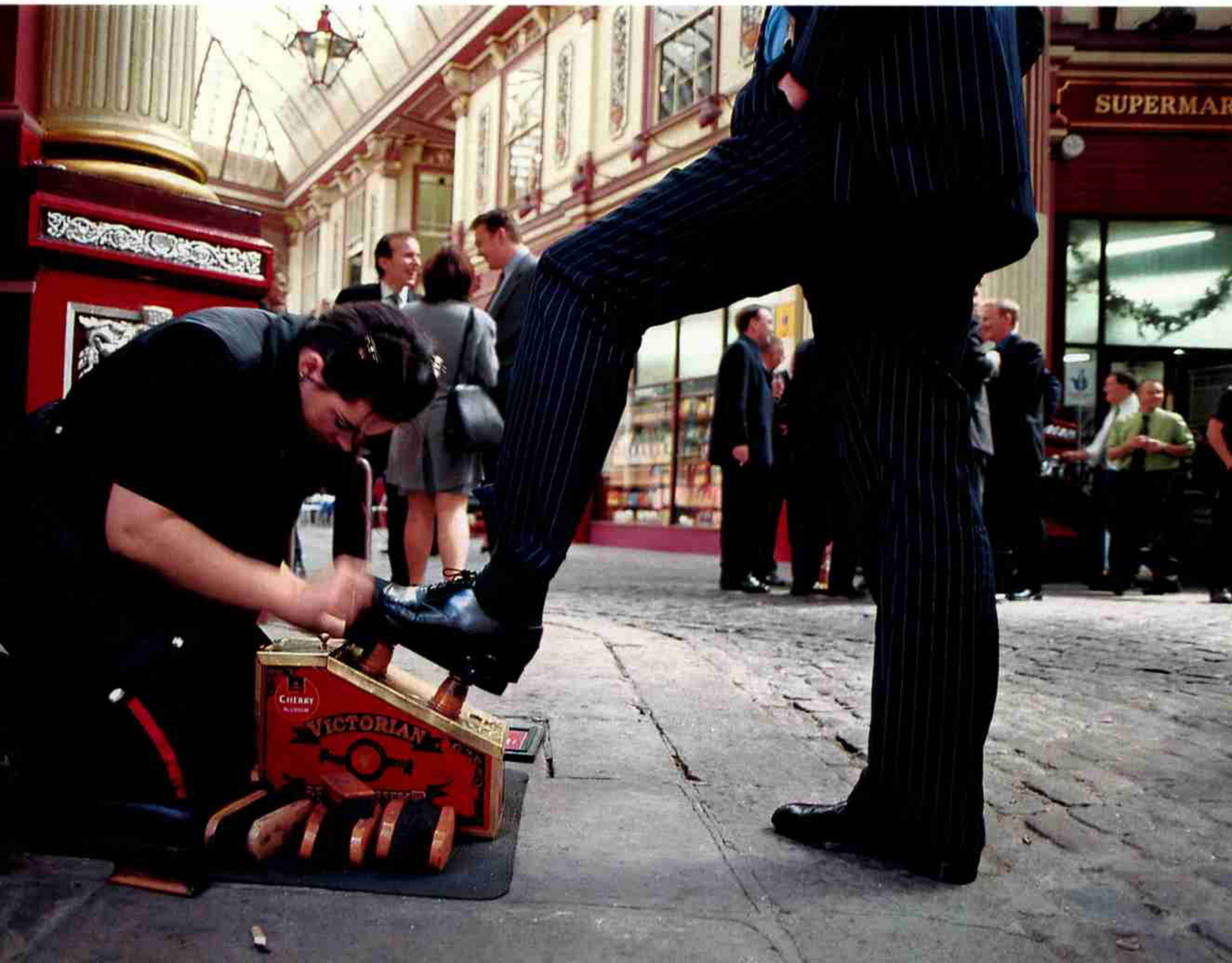
More than 65,000 French citizens are registered in Great Britain, and unofficial estimates put the number of French in London as high as 100,000, with more arriving every week. Richard Pak, a 26-year-old photographer from Paris, described his arrival with the sort of wide-eyed excitement that I felt for his city in the 1960s. "London is very exotic," he said. "When you take Eurostar from Paris and arrive here, you feel something in the air."

We were sitting near Leicester Square at the Charles Péguy center, financed by a French charitable trust. For 50 pounds (about $80 U.S.), French citizens can refer to the center's job and accommodation lists and get advice on everything from writing a résumé in English to negotiating Britain's tax and health-care systems. "You can come here on Monday morning," said Richard, pushing back his tousled chestnut hair, "and be working on Tuesday." Many jobs taken by the French are in the catering or hotel industries.

Meanwhile some French companies, driven out by high taxes and labor costs, are moving to London. Even the national airline, Air France, has its European call center in London. Sacks full of francs are following. One French newspaper has compared this flight of money and manpower to the exodus of the Huguenots at the end of the 17th century.

GEOGRAPHICALLY and politically the United Kingdom may be on the fringes of Europe, but London has become, economically and culturally, the de facto capital of Europe. At the same time, it feels more European than ever. This can be seen in the way Londoners have discovered the street. When I was young, Soho was a backwater stalked by sleazy men in raincoats, but as I walked around late on a warm summer evening, there was a boisterous, carnival atmosphere. People spilled out of pubs with their pints; a young couple stood locked in a

just get left farther behind.





Cheers, mate



Indulging in tradition, a fellow downs a pint of bitter at Lamb Tavern, famous among City workers for its beef, beer, and smoky conviviality. Founded in 1780, rebuilt in 1881, the Lamb is an Old World bastion. Says one patron, "It's principally a man pub."



Hip hair draws few stares at Camden Lock Market, where pierced patrons spark new fashion trends. In more eye-catching garb, a woman mourns at Kensington Palace on the second anniversary of the death of Diana, Princess of Wales. Angry notes decried royal "bitterness" toward Diana, still revered as the "people's princess."

passionate embrace in an alleyway off Dean Street; gangs of girls with bare stomachs and studs in their navels sat at pavement cafés gossiping or ogling the boys.

There may not yet be a Minister of Rock and Roll (though Mick Hucknall, lead singer of Simply Red, last year joined a Tony Blair-led task force on pop music), but in no other city are the cultural habits and the economy so driven by youth and pop culture. Stefan Schulz-Rittich, a 23-year-old from Cologne dressed in faded jeans and scuffed skateboarding shoes, remembers the first night he dived into London's club scene. "It was a Thursday night, in February, and I went to a club called the Velvet Underground on Tottenham Court Road," he said as I sat in Regent's Park with a group of students from the University of Westminster. "It was just amazing. There was really great music, and I met loads of people from all over the world. It was almost spiritual."

"My picture of London before I came here was very old-fashioned—people drinking tea at 4 p.m. and everyone being very polite," said Ximena Cordova, a 24-year-old from Bolivia. With her Latin looks and azure blue sweater, set off by a white lily tucked into her hair, Ximena looked like one of those brilliant, exotic creatures you find in the rain forest. "But London is a very free place. I lived in Barcelona before, and London is much more tolerant, much more cosmopolitan."

London's broad-mindedness has made the city a magnet for homosexuals. "I feel like I'm part of the driving force of London," said Carl Gobey, 23, who is gay. A sociology student from Britain's second city, Birmingham, he is one of the 30,000 young people from other parts of Britain who pack a suitcase and, with a bit of money and a lot of hope, head for London each year to reinvent themselves. "Everything is here—different nationalities, different people, different styles and fashions. Anything you want to be, any life you want to lead: You can find it."

This golden age has a dark side. In a church graveyard in Brixton, I saw marijuana and other drugs being dealt among the tombstones.


31st AUG
1997
"I STILL
REMEMBER YOU"
Diana,
in Australia

Across the road at the Fridge, 2,000 Generation Xers were dancing to the sound of Basement Jaxx, one of the hottest acts on the city's club scene. Many of the revelers were clearly high. A whole cottage industry of illegal drug factories supplies "dance drugs," such as ecstasy, amphetamines, and the anesthetic GHB. Hard drugs are also increasingly available. Last year some of London's poorest areas were flooded with three-dollar bags of heroin. "It's easier to get drugs in London than it is to get a taxi," John Ellis, a 24-year-old recovering addict, told me.

AT LAST it is also just as easy to get good food. A journey to London used to be a gastronomic Calvary, but with more than 6,000 restaurants serving dishes from every corner of the planet, London may now be the most cosmopolitan culinary center anywhere in the world.

"The sea bass is the top bollocks today," said Steve Carter, the Yorkshire-born head chef at Bank, a huge—and hugely popular—new restaurant in the heart of the West End. I had signed up to be a sous-chef for a day, and now I was struggling into a black chef's jacket, a pair of black-and-white pinstripe cotton trousers, and an apron. It was nearly midday, and the lunchtime rush was building. My fellow sous-chefs were from Sweden, New Zealand, Australia, France, and Italy. Steve strode up and down like Nelson before a naval battle, tasting sauces, checking ingredients. "I'm a bit worried about the langoustine," he said. "I have only a hundred portions. Let's just hope it's enough."

Bank is owned by Tony Allan, a working-class Londoner who took one of the city's oldest trades, fishmongering, and remade it. The fish served at his restaurants comes from sustainable sources, he says. Genetically modified food is prohibited—notices at each restaurant read, "This is a GM-free zone!"

"I was a chef originally," Tony explained, as Bank began to fill up. With his glowing tan, white jeans, denim shirt, and flowing locks, he looked like a pop star. "But I got the sack because I was always complaining about the quality of the fish. So I started going to the coastal markets, places like Hastings on the south coast, buying fish to supply to restaurants. One man with a van sort of thing."

Fourteen years later he supplies three-quarters of all fish used by London's restaurants, the van is a Ferrari, and Bank Group Restaurants is a publicly traded company worth 100 million pounds (160 million dollars). Such success stories have a long tradition; London's most famous bit of folklore tells of a poor country boy named Dick Whittington, who arrives with his possessions tied in a bundle at the end of a stick and ends up rich and famous. And though Allan isn't the mayor of London, as Whittington was, it is entrepreneurs like him—savvy, ambitious, quick to spot the main chance—who have always made London rich. Today he lives in a mansion in Kent and indulges his passion for falconry.

"I fly a bird called the European merlin," he said. "I used to have a perch in my car, in the front by the dashboard. So I'd be driving along with two falcons sitting in the passenger seat."

Everything is here. Anything you



Preening is a serious pastime for London's "It girls"—beauties like Alexandra Aitken who serve as fashionable and ubiquitous adornments on the party circuit. "They're world famous in London," jokes one public relations agent. In its way, the town Dickens quaintly called a "magic lantern" has become "It" among global cities, beaming with the intensity of a socialite's smile.

I asked Allan what he looks for in a fish.

"Good slime," he said without a moment's hesitation. "And firm flesh."

Like sex, the preparation of food was something the British as a nation did discreetly, behind closed doors. Indians filled their homes with the pungent smell of curry. The Chinese sweated over flaming woks. The British cooked bland dishes in well-ventilated kitchens. But today Londoners dine out with the gusto of Neapolitans, and the sight and smell of cooking are a key ingredient of the experience.

Like many of London's new restaurants, Bank has its kitchen in the middle of the dining area—a stage on which, twice daily, a noisy, olfactory drama is performed. Theater and spectacle have always been at the heart of London's life. Or, as Shakespeare put it: All the world's a stage. At Bank, the clank of pots and the billowing of smoke were the stage effects; my fellow sous-chefs and I, the actors. For maximum theatrical effect we bellowed each order at the top of our lungs and sprinkled our dialogue with French.

"105!" roared Steve Carter, spiking an order. "One chateaubriand! One calf's liver!"

"*Ça marche!*" came the answering cry from inside the kitchen.

My job was to see that each dish was accompanied by the correct side orders. By 1:20 p.m. we were handling 55 main courses simultaneously, and I was sweating like a stevedore.

Through the plate-glass windows I could see the crowds surging along the sidewalks. Black cabs weaved through the cars and buses on their way to Trafalgar Square. As I watched them go by, I felt a wave of affection for this great city, which, like an ancient coral reef, has gone on shifting and growing, adapting itself to the needs and the dreams of each new generation for nearly 2,000 years. □

Speak English but need a translator for London? Take a playful look at the language we share and comment online at *www.nationalgeographic.com/ngm/0006.*

want to be, any life you want to lead.





DEBUT

SUE

CHICAGO'S FIELD MUSEUM UNVEILS THE WORLD'S MOST FAMOUS T. REX

BY DONOVAN WEBSTER
PHOTOGRAPHS BY IRA BLOCK

In the next year almost two million people are expected to meet "Sue," one of Earth's largest ever land-dwelling carnivores, nose to nose.

THE T. REX IS BEGINNING TO RISE. TOWERING 14 FEET OFF THE GROUND—ITS HEAD AND MASSIVE NECK CAUGHT IN STARTLED MID-SWING—flashingly lit by a metalworker's sparks and the leaping light from a blacksmith's forge, the thing seems almost to breathe. A fine art foundry outside Trenton, New Jersey, is not a likely place to find what is probably the world's most famous dinosaur fossil. But here, in a building protected from the hustle of modern life by razor-wire fences and a state-of-the-art security system, is "Sue," the *Tyrannosaurus rex* fossil purchased at auction by Chicago's Field Museum in 1997. For the first time in some 67 million years, it is standing upright.

The building is home to Phil Fraley Productions Inc., among the world's premier creators of museum exhibits. In the midst of the hubbub, talking over the din of metalworkers creating an elegant and almost invisible armature to support the Sue skeleton, is Fraley himself. A solid man in his 40s, with the soul of an artist and the physique of the college football player he once was, Fraley is watching and considering every aspect of the armature's fabrication: fretting about the pitch and angle of Sue's hips ("We have to be most careful with the hips," he says, "since everything else on a *T. rex* relates to them"), wondering if some steelwork will be unnecessarily visible, pondering the angle of Sue's enormous birdlike foot.

"The fossils are beautiful," says sculptor and metalsmith Leslie Ewing (below). "There's so much variation in color and texture." She fits a slender steel rod to the chevrons on the underside of Sue's bulky tail, while her colleague Paul Zawisha





adjusts the armature that clasps hulking neck vertebrae. The Field Museum's challenge to the Phil Fraley Productions team assembling Sue: Every fossil must be totally secure *and* readily removable from the mount for study. Says Zawisha, "There's no room for error."

Sparks fly. The shriek of steelworking tools fills the building. "This project has been a challenge but a fun one," Fraley says. "Our contract with the museum calls for us to make an armature that leaves every bone removable at any time for scientific study. So we're fitting them all in saddles; each bone's weight is what holds it in place."

Ahead of us, a young jewelry designer named Leslie Ewing is working on a saddle to hold one of Sue's cervical vertebrae. Made of carbon steel, the support resembles a pair of cupped hands bound together at the wrists. Its spreading array of fingers fits snugly around the contours of the bone's underside. Ewing feels for gaps between the steel and smooth bone, then removes the saddle and walks to a blowtorch nearby. Dipping one of the saddle's fingers into the flame, she brings the steel to glowing red-hotness and gently bends it to better clasp the fossilized bone.

After the steel cools, Ewing checks the fit. The saddle cradles the 20-pound bone tightly and almost invisibly, virtually disappearing into natural fissures in the vertebra. Eventually the bottom of this saddle will be bolted to the armature, which is supported by a narrow steel pole that emerges from the base of the Sue exhibit in Chicago. When the job is complete, after 15 months of solid work, more than 200 bones in Sue's body will be supported by variations on this theme.

"That's why I love this," Fraley says, watching and smiling. "It's part sculpture, part biology. Between the museum staff and ours, we've got all these skilled people taking an inanimate object—a pile of fossilized bone—and returning to it a semblance of life. We've thought about its posture. We've worked out how it would stand and move in life. We've thought

DONOVAN WEBSTER is working on a book about crossing the Sahara, a subject he covered in the magazine's March 1999 issue. He and photographer IRA BLOCK collaborated on our first story on Sue (June 1999).

ABOUT SUE

THE LIFE STORY OF ONE ANIMAL RECORDED IN THESE BONES OFFERS INSIGHTS INTO AN ENTIRE SPECIES.

The **olfactory bulbs** (white), which receive information from smell receptors in the nose, are nearly as large as the rest of the brain (yellow). "When Sue explored the world," says Brochu, "it was nose first."

This bone resembles a **furcula,** or wishbone, a feature shared by birds and some other theropod dinosaurs. Sue is the first *T. rex* found with such a bone.

With one of only two *T. rex* **forelimbs** known, Sue may help scientists understand the way the species used its tiny but heavily muscled arms.

The **pelvis** indicates that Sue lived a long life. The **ischia** and **pubes** in most tyrannosaurids are separate, but Sue's are fused. In living animals such bone fusion is most commonly seen in older individuals.

Sue's **stapes,** a six-inch-long middle ear bone, is the first found in a *T. rex.*

One of Sue's **teeth** is a foot long from root to tip. It's the largest tooth yet described from any meat-eating dinosaur.

0

2 feet



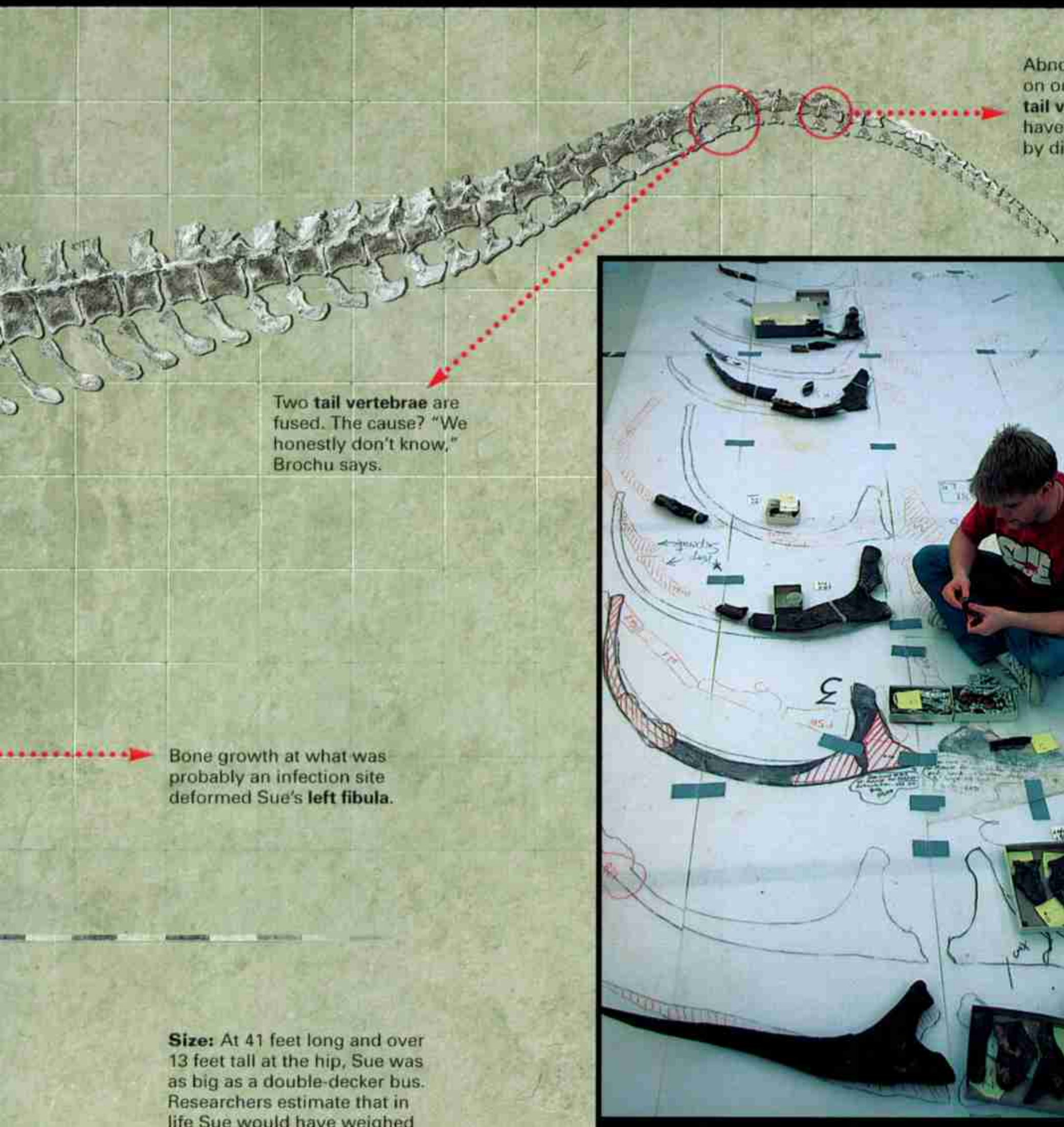
Field Museum chief preparator Bill Simpson lays out Sue's **gastralia,** riblike bones that helped support the animal's deep belly. Only a few gastralia are known from other *T. rex* specimens, but Sue's set is about 70 percent complete.

In crocodiles—close relatives of dinosaurs—the thighs jut out at an angle from the hips. But *T. rex* **thighbones** extend straight down from the pelvis and would have given Sue a leg-swinging stride like that of modern mammals. Sue's exceptionally well-preserved bones show where muscles attached and the extent of joint cartilage, allowing researchers to estimate how far the legs would have moved when Sue walked.

BUILT TO MOVE



"WE HAVE ALL THE IMPORTANT PIECES," says lead Sue researcher Chris Brochu. "Because they're from a single individual, we can begin to draw new conclusions about locomotion, growth, and the relationship of *T. rex* to other dinosaur species."



Abnormal growth on one side of this **tail vertebra** may have been caused by disease.

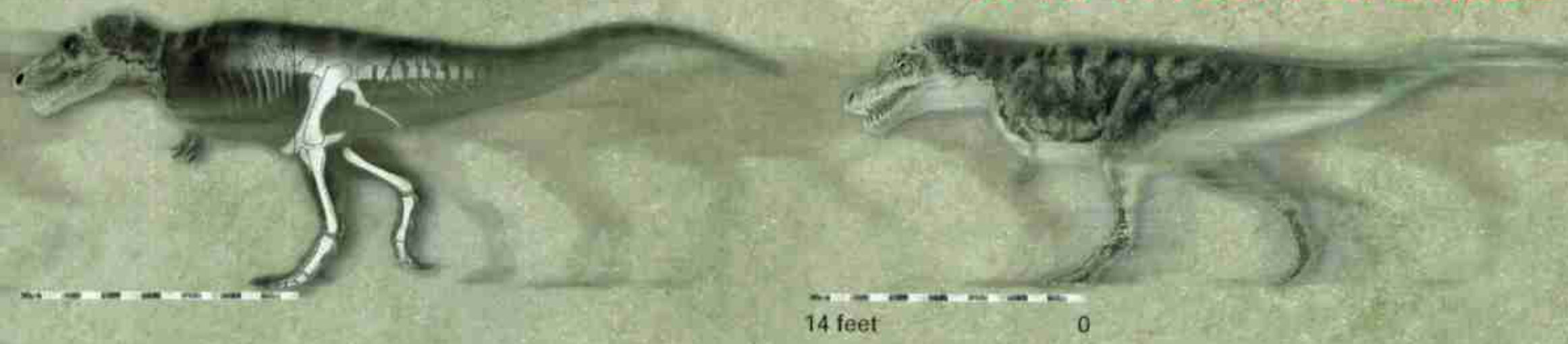
Two **tail vertebrae** are fused. The cause? "We honestly don't know," Brochu says.

Bone growth at what was probably an infection site deformed Sue's **left fibula**.

Size: At 41 feet long and over 13 feet tall at the hip, Sue was as big as a double-decker bus. Researchers estimate that in life Sue would have weighed some 14,000 pounds. Like most other reptiles, dinosaurs continued to grow throughout their lives, but even for a dinosaur, Sue was formidable.

Fossil preparator Paul Brinkman reassembles the fragments of Sue's right ribs—a 3-D jigsaw puzzle.

12 TO 14 FEET PER STRIDE



ART BY DOUGLAS HENDERSON AND DOUG STERN

about how to best engage viewers in seeing Sue, having a relationship with it. And now we get to make these ideas reality. Who could ask for a more interesting job than that?"

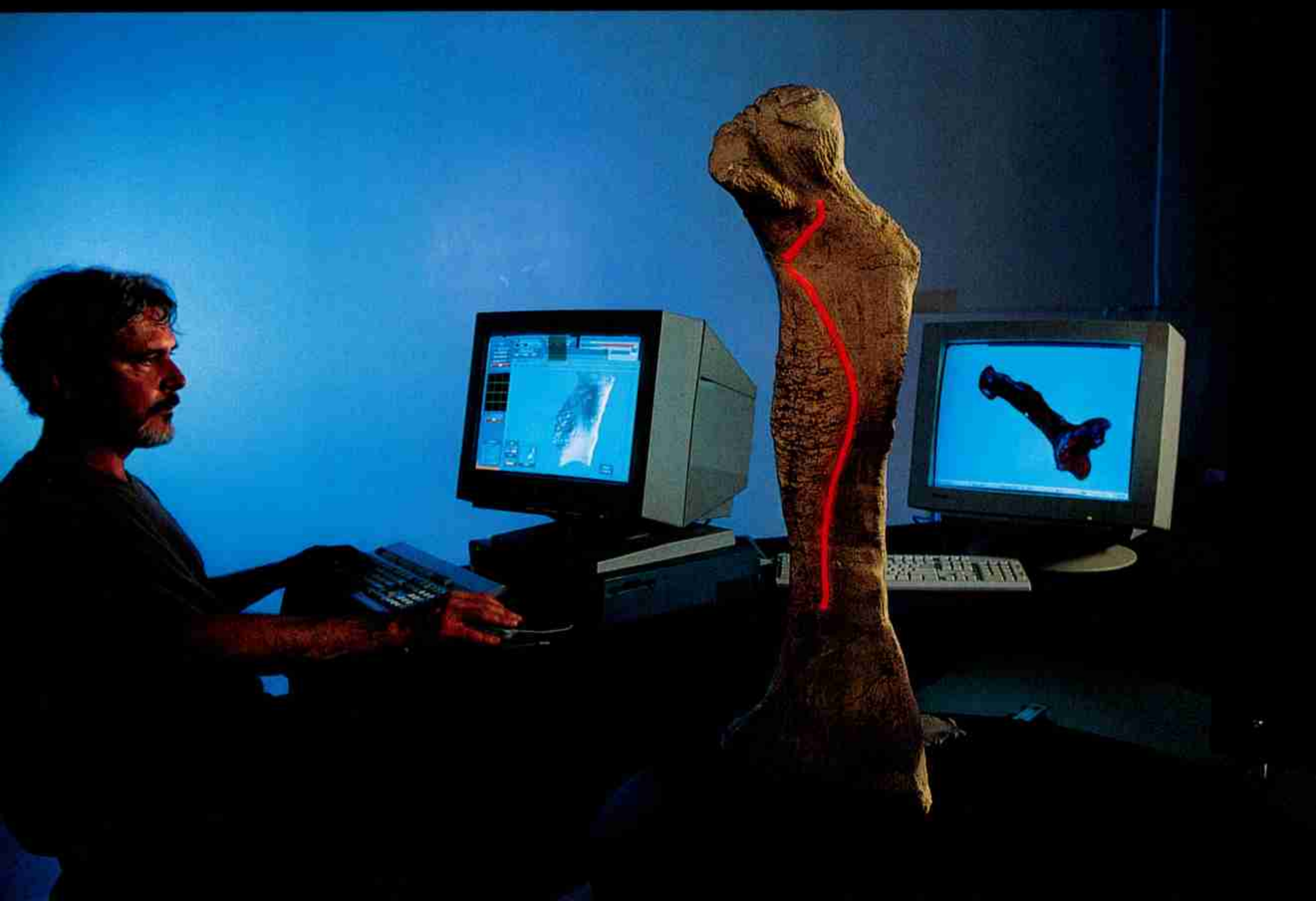
WHEN YOU CONSIDER that Sue's bones are among the most significant evolutionary gems discovered in decades, it makes sense that jewelry designers should be working alongside biologists and paleontologists on returning them to their former glory. But not only jewelers have brought their talents to the project. Before Sue is unveiled on May 17—in the museum's massive Stanley Field Hall—nearly two dozen museum preparators will have put in some 30,000 hours on the fossil skeleton.

Aside from the preparators—who for two years have painstakingly stripped off the rock, or matrix, surrounding the fossilized bones and re-created a number of missing bones—paleontologists have examined and scientifically described the specimen, a CT-scan team has used powerful x-rays instead of saws to dissect the bones, and a project manager has kept the efforts gliding toward completion.

No dinosaur has ever drawn so much attention. The Chicago Chamber Musicians have commissioned composer Bruce Adolphe to write *Tyrannosaurus Sue: A Cretaceous Concerto.* A seven-movement piece based on the life and times of Sue, the concerto evokes what life was like toward the end of the late Cretaceous period, when the dinosaur roamed what is now South Dakota. Scholastic books will publish several titles about Sue—both fiction and nonfiction. And two of the casts being made of the big *T. rex* will be included in a pair of traveling exhibits sponsored by McDonald's and scheduled to make more than a dozen stops around the United States. Another of the casts will be on permanent display at Disney's Animal Kingdom near Orlando, Florida.

That's a lot of hype to live up to. But then, clamor has followed Sue since the specimen was discovered in 1990. That was when the eponymous Sue Hendrickson, a field collector

Field Museum preparators Jennifer Moerman and Matthew Groves (right) used old-fashioned muscle power to remove rock from Sue's nearly complete set of bones. New technologies helped fill in gaps. A laser scanner and computer-guided lathe





created a mirror image of one of Sue's right foot bones to stand in for a missing left one. "Originally these tools let moviemakers create imaginary dinosaurs," says Dave Bassett of California's Scansite 3D (left). "Now scientists use them to study real dinosaurs."

for the Black Hills Institute of Geological Research, took a "fossil prospecting" walk one morning and found three large vertebrae sticking out of the side of an eroded cliff outside Faith, South Dakota. "By their shape I knew the specimen had been a meat-eater," says Hendrickson, "and by their size I knew it could only be a *T. rex*." We will probably never know, however, whether Sue was male or female.

Unfortunately for the Black Hills Institute the specimen was found on the ranch of Maurice Williams, a Cheyenne River Sioux whose land is held in trust by the U.S. government. Though the institute paid Williams $5,000 for what it believed were the rights to Sue's bones, the U.S. government had not granted permission for the excavation, setting into motion a battle for Sue's ownership.

Three years later a U.S. district court ruled that the fossil belonged to Williams, after which the Bureau of Indian Affairs granted him permission to sell it. In 1996 Williams decided to auction the specimen at Sotheby's. The following year, after a frenzy of bidding, the Field Museum walked away with Sue for a price of 7.6 million dollars (8.36 million with Sotheby's commission), turning the sale into international news.

Around the Field Museum and across Chicago, a cheer went up. Chicago now owned the world's largest *T. rex:* an animal 41 feet long, standing more than 13 feet tall at the hip, and with an estimated live weight of some 7 tons. It was also the most complete *T. rex* ever discovered, with about 90 percent of the skeleton accounted for. The city had a new mascot, the museum a new focal point. But inside the museum's walls there was also apprehension.

"Before we could show Sue off, we still had a lot of work to do," says John Flynn, chairman of the museum's department of geology, which oversees paleontology. "The specimen was only about a quarter prepared; the rest of it was still encased in rock. Before we could display it, we

had to address questions like what's the best way to study it, and where do we put it? We had to make these decisions quickly."

It has been a fevered two years. The museum has finished preparing Sue's bones. Chris Brochu, a museum paleontologist, will soon publish the first comprehensive study of a *T. rex*. The museum is developing a Sue-centered dinosaur exhibition hall that will open around 2003. Before then Sue will dominate the soaring marble space of Stanley Field Hall.

Once the location was fixed, Sue's posture had to be agreed on. "We wanted it to be dynamic," says Flynn, "to convey that this was a living animal." After several drawings—Sue in hunting posture, leaping, even sleeping—the museum's team came up with a winner.

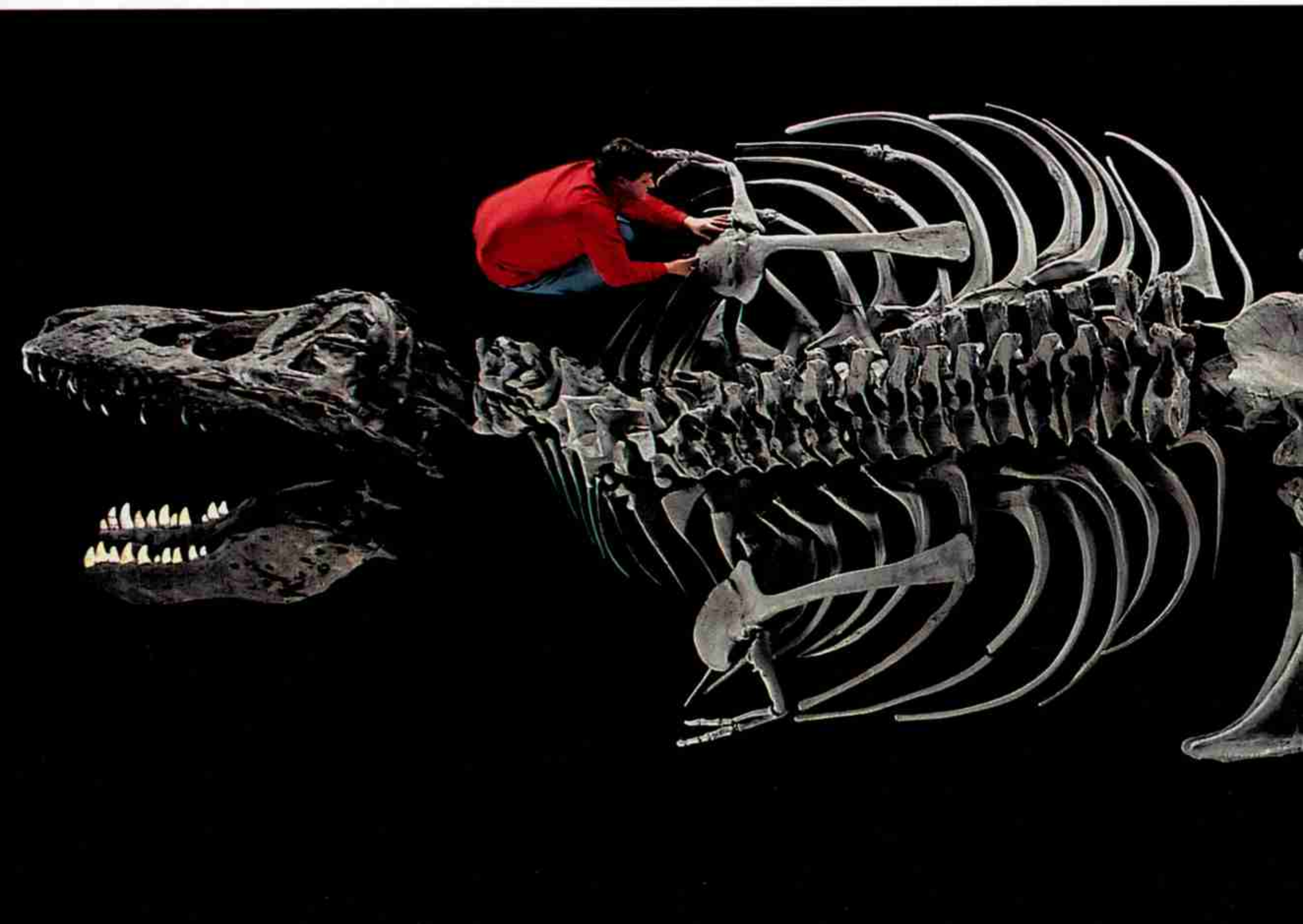
"The specimen will be placed on a base that mimics shattered rock," says designer Phil Fraley. "It looks sort of like a fallen bridge. And the specimen itself will be crouched and turning slightly, like it was in the midst of eating when something—maybe the viewer—startled it. The pose creates tension, a relationship between the viewer and Sue. We wanted that 'What if?' sense. You get a real jolt standing there and addressing one of the largest meat-eaters to ever walk the planet."

Beyond these big pushes a welter of smaller decisions had to be made. Sixty-seven million years under the earth had distorted parts of Sue: Its skull was slightly flattened, some bones had been misshaped by the geologic pressure, other bones were shattered.

It was up to the museum's paleontology staff to decide whether to "undistort" parts of the dinosaur—making it look more lifelike but also more like a generic version of *T. rex*—or to keep its fossilized shape.

One of these decisions proved easy. Thanks to its hefty facial bones and long dagger teeth, Sue's fossil skull and jaws weigh nearly 750 pounds. Consequently, mounting them at the end of the skeleton's long neck could prove dangerous. "So we made a cast that weighs roughly 150 pounds," says John Flynn, as he walks me through Stanley Field Hall, "and we'll mount that on the actual skeleton. That way, we can also undistort the skull a little without damaging the real specimen."

Flynn points toward a broad, second-floor landing overlooking the hall. "The real skull will go up there," he says. "We're building another entire exhibit around it. A place for



people to learn about Sue and look down on the skeleton, where they can touch casts of the bones and actually get close to the real skull."

Flynn leads me upstairs and through a maze of hallways, finally entering a fossil preparation lab on the third floor. Arranged on tables around the clean, brightly lit room are bones from Sue, each smooth and dark as richly aged hardwood. Spread across one table is the cast of Sue's skull—the one that will sit on the mounted skeleton—still in pieces and ready for gentle revisions.

"What we're going to do by undistorting this cast," says Bill Simpson, the museum's chief preparator of fossil vertebrates, "is make the more distorted side of the skull a little less flattened and crushed. We'll raise and straighten the midline of the snout, making it more symmetrical. We don't want to do too much, though, because then everything else changes. If you do too much to the palate, the orientation of the jaws and teeth changes."

Simpson and Flynn now take me to a sealed room off the back of the lab. There, the real Sue skull sits atop a custom-built crate. Just as the skull's frontal bones have been distorted on the left side, the left postorbital, parietal, and squamosal bones—from the top of the skull behind the eye—moved out of position during burial and fossilization.

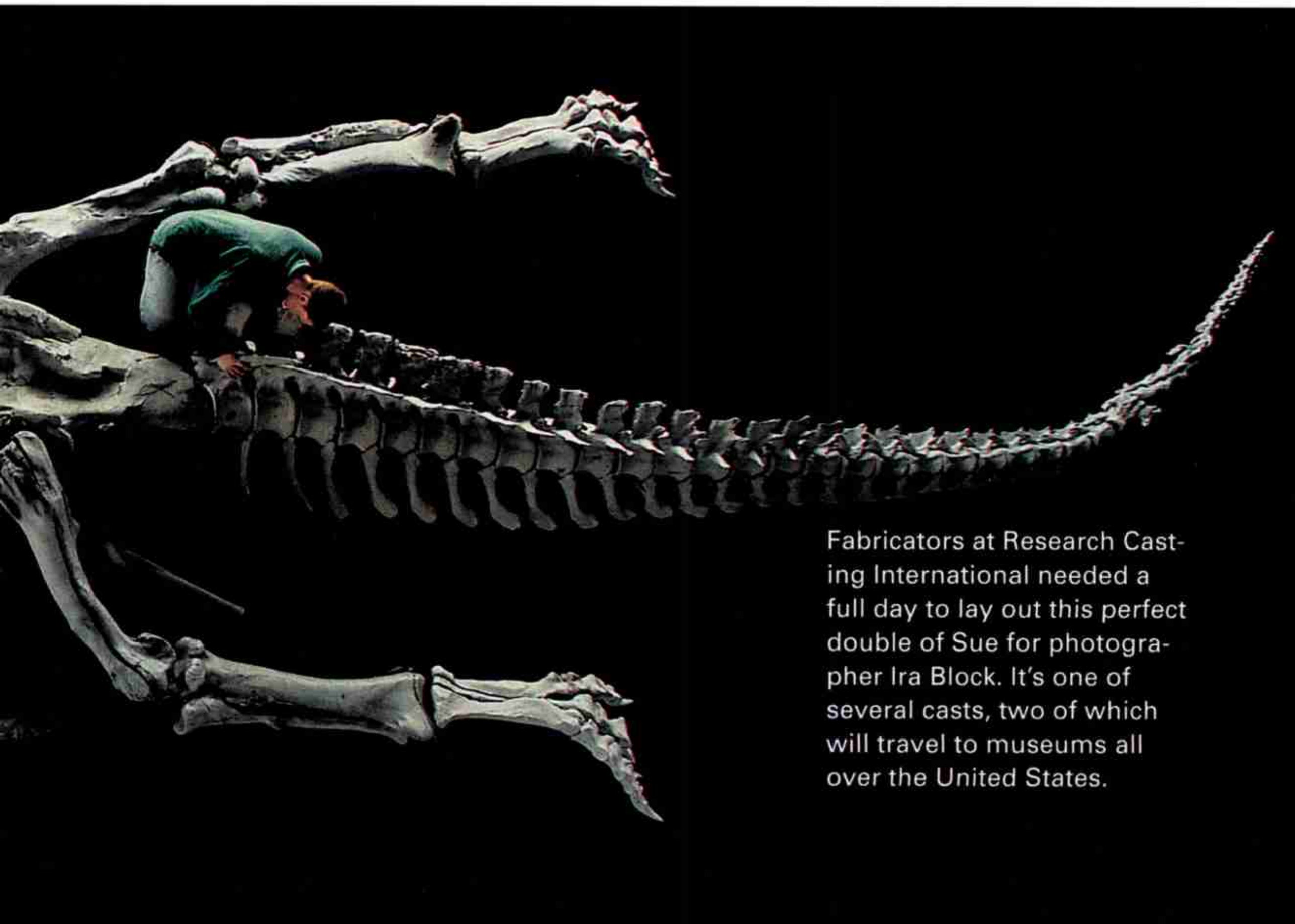
"We still have the displaced bones, though," Simpson tells Flynn, grabbing the mahogany-colored bones from their resting places on white foam pads nearby. Simpson fits them in place and regards the fit, which remains rough.

The skull's right side is a smooth line, but the left bumps out strangely. "That's what I mean about trying to fix imperfections," Simpson says. "How much do we want it to imitate life as opposed to the way we found it?"

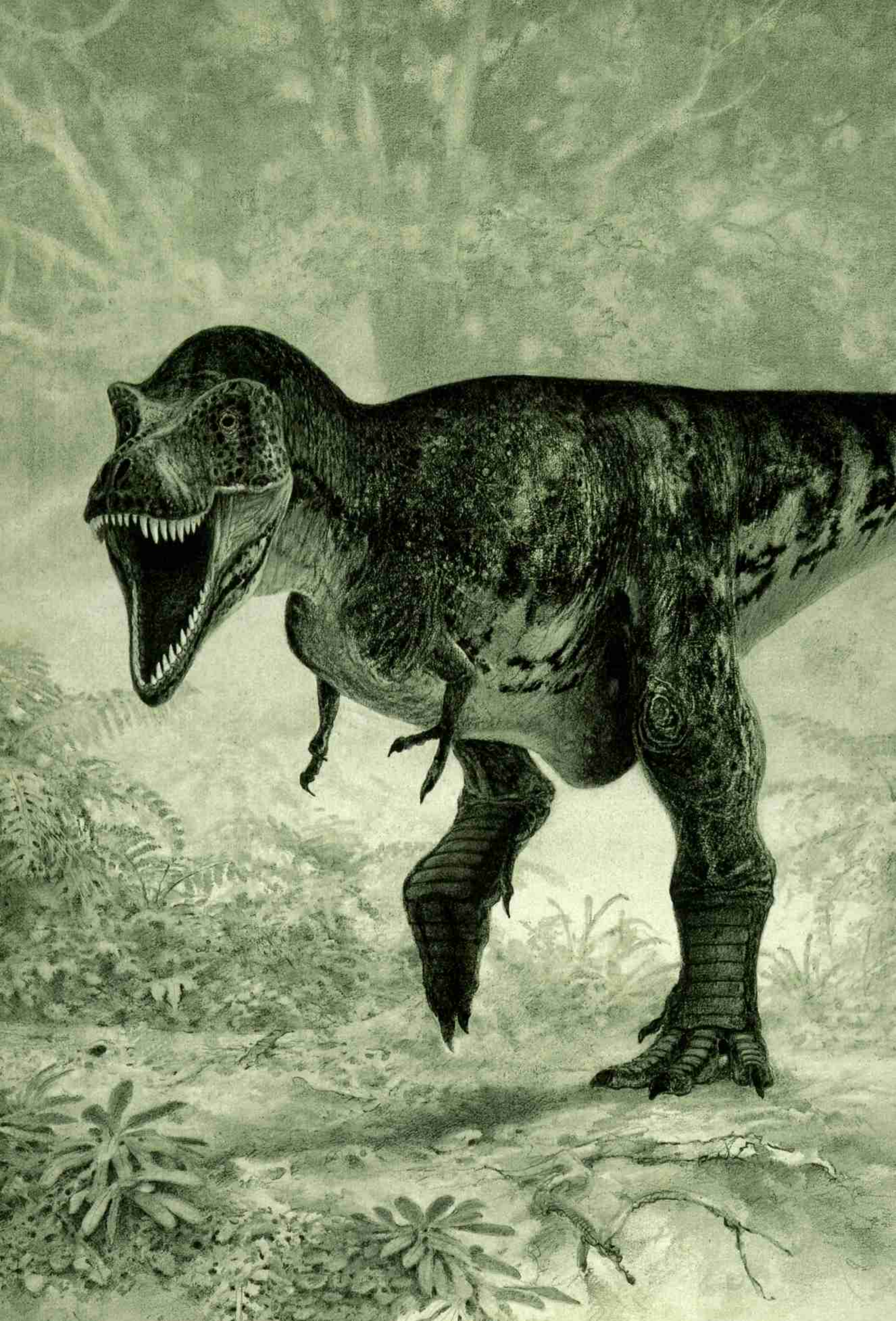
Ultimately, it's decided the bones will be epoxied back into place, despite their imperfect shape. "I think it fits better to life this way," Flynn says. "And casting them before fitting them back into the skull allows for better scientific study too. Those are advantages I like."

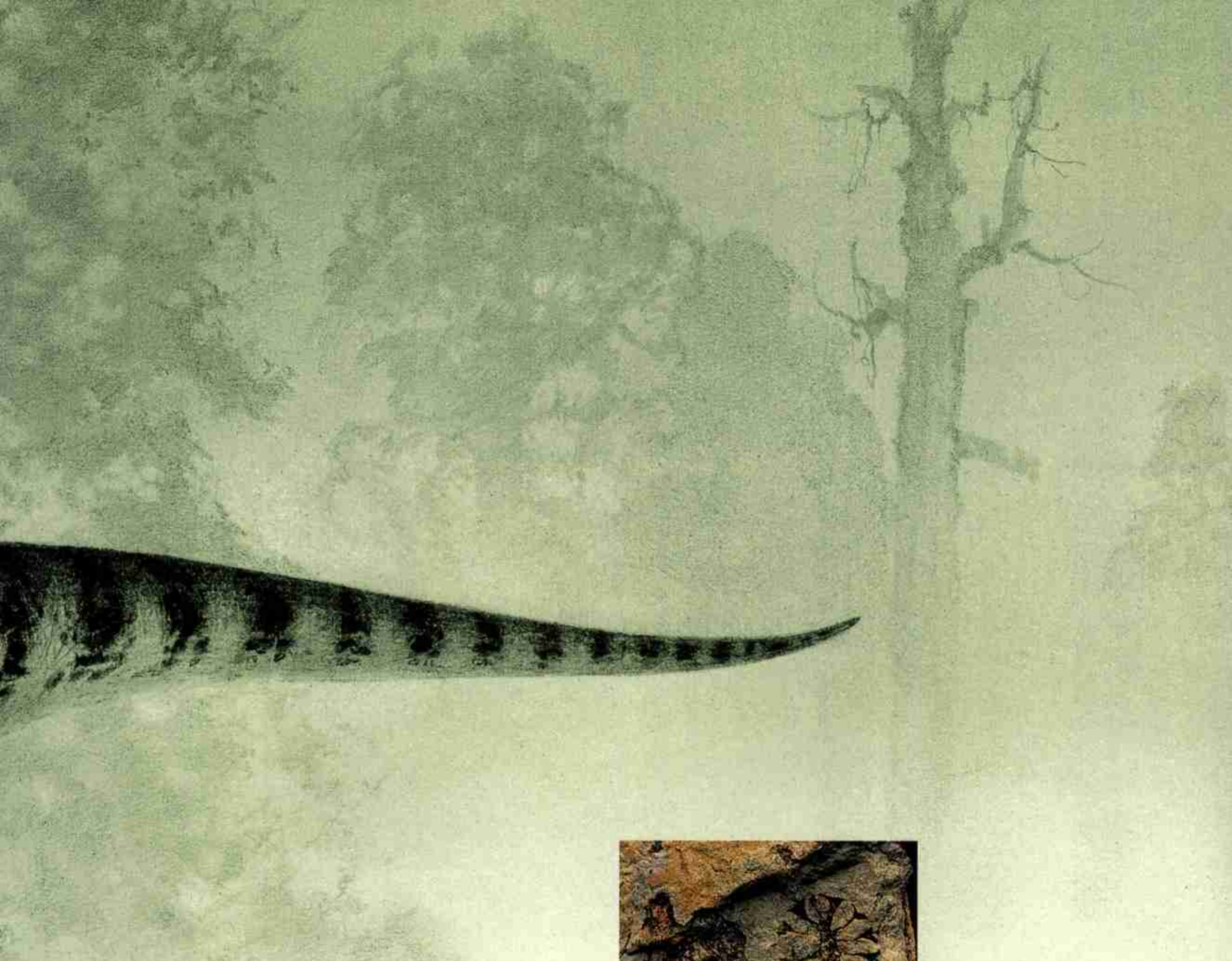
Flynn and Simpson want to show me one of Sue's imperfections. Across the hall, on a table in Simpson's sprawling office, are two tail vertebrae that fused together during Sue's lifetime. The bones are a big, knobby mass of calcified clumps, not at all like the other smoothly curved tail vertebrae being mounted in Fraley's New Jersey warehouse.

As we regard the freakish bones, Flynn is smiling. "I like these fused vertebrae so much,"



Fabricators at Research Casting International needed a full day to lay out this perfect double of Sue for photographer Ira Block. It's one of several casts, two of which will travel to museums all over the United States.





What was Sue's world like? Fossils of broad-leaved plants, conifers, and ferns (this page) recovered from the same arid and rocky South Dakota site where Sue was found indicate that some 67 million years ago the environment was warmer and wetter than today, offering plenty of forage for the plant-eating dinosaurs that in turn became *T. rex* meals.

Was Sue a hunter or a scavenger? Probably both, many scientists say. *T. rex* was well suited for hunting but could also have bullied other hunters to abandon their prey.

ART BY DOUGLAS HENDERSON

Bone by bone, scientists and exhibit builders have worked for two years on the world's biggest *Tyrannosaurus rex*. Chicagoans eagerly followed each step as museum staff members prepared the fossils. "We've had people come in a dozen times

he says. "They show Sue was a living animal once. It had injuries or diseases or infections that left it damaged. It shows that Sue is not only an example of *T. rex* as a species but was an individual animal too—and one that spent its days with a backache."

Just up the tabletop from the vertebrae sits a short, flattened bone about the shape and length of a beef rib you might find on a backyard barbecue grill. "This is one of the gastralia," Flynn says. "It's one of the belly 'ribs,' from below the rib cage, closer to the pelvis. As we've prepared Sue, we've found about 70 percent of these—which is extremely high for *T. rex*. Until we found these, nobody could say much about this part of its anatomy."

Another intriguing find unearthed by the Sue preparation team is a stapes: a delicate six-inch, piston-like rod of bone connecting the outer ear's tympanic membrane to the inner ear's auditory canals. Finding one of these in a *T. rex* was a first. It may also help scientists locate *T. rex*'s position in evolution—and give an idea of how *T. rex* heard the world around it.

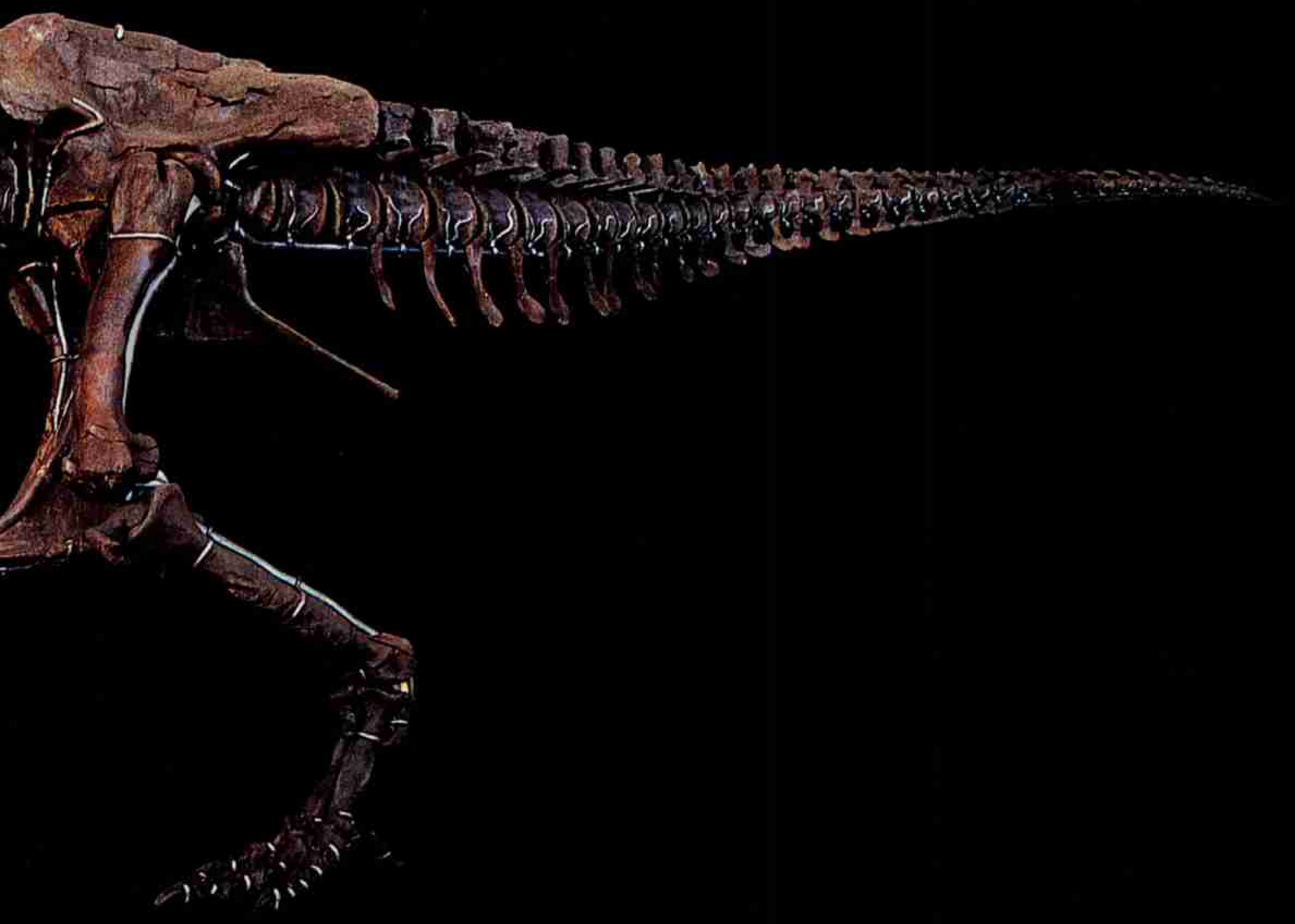
Near the edge of the table sits a thick and strikingly blue bone about the size of a large ice-cream cone. "That's a replicated toe bone," Simpson says. "It's a mirror-image model, made from the same bone on Sue's opposite foot." The blue toe bone—made of plastic—will be sanded and painted a reddish brown before it's mounted into place. When Sue is finished, any bone that has been sculpted or cast will be painted this same reddish brown, to distinguish it from the deep brown of the true fossil bones.

"People get a thrill seeing the real thing," Simpson says. "All of us like being close to an object that's 67 million years old, especially when it was once a gigantic animal that walked the Earth. We love being able to show this isn't a replica or a fragmentary specimen. This is the real animal, right before your eyes."

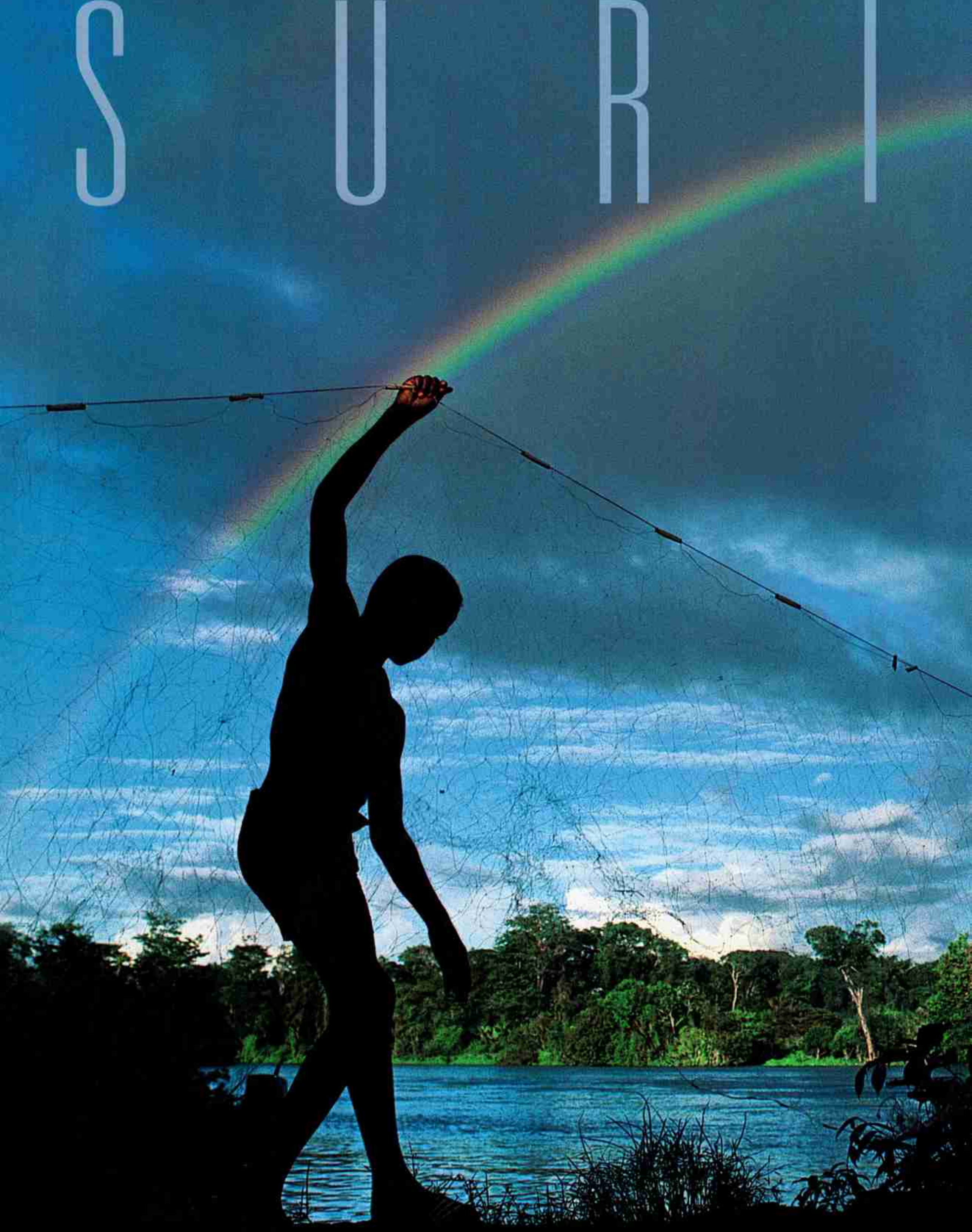
And now, after 67 million years in obscurity, Sue the *T. rex* again towers above the Earth, commanding the attention of all below. □

For an insightful look at Sue's skull see the CT scan at *www.nationalgeographic.com/dinorama/sue.html.*

in the past year just to see what's new with Sue," says project manager Amy Louis. "We call them Sue groupies." But Sue is much more than a celebrity, says John McCarter, the Field Museum's president. "This is a scientific treasure we've only begun to understand."



SURI



Can the rain forest

N A M E

Working out tangles in his fishing net, a descendant of escaped African slaves ends his day on the Tapanahoni River. Suriname is home to a spectrum of native, Asian, African, and European cultures struggling to build a common future.

save South America's youngest nation?

BY JOHN McCARRY • PHOTOGRAPHS BY ROBERT CAPUTO

DEEP IN THE RAIN FOREST OF SURINAME, by the Sipaliwini River that runs brown and slow through the Indian village of Kwamalasamutu, the shaman administered an examination to his apprentice. The shaman, squat and strong with glossy black hair cut in a straight edge across his forehead, watched his young apprentice spread the forest plants he'd spent the morning collecting across the rough plank floor of a hut. The student, a Tirió

Lacking roads and rails, Suriname's interior can be crossed only by airplane, offering sights like the "Devil's Egg." The granite pinnacle rises from the folds of the Central Suriname Nature Reserve, off-limits to logging and mining.

Indian, picked up cuttings and pointed to parts of his body to illustrate which maladies each plant could cure. In a voice quiet as the river, he said a plant the Tirió call *ko-noy-uh,* a member of the ginger family, can treat colds and sore throats. He explained how *pah-nah-ra-pah-nah,* a vine related to the North American pokeweed, can be rubbed into the hair to kill fleas and lice. He told how the sap of a woody vine, *tah-mo-ko ah-nu,* can cure children's fevers. The shaman was pleased with his student's progress.

SCENES SUCH AS THIS are taking place throughout much of Suriname's rain forest, largely because of the efforts of Conservation International (CI), an environmental organization working with local peoples to preserve the country's cultural and natural resources. One way the group does this is by sponsoring the Shaman's Apprentice Program, which relies upon native botanical knowledge to help researchers in the United States identify plants that may be developed into pharmaceuticals.

"Men like this shaman are a treasure trove of learning," says Stan Malone, director of CI's Suriname office, whose ancestors were brought to this former Dutch colony as slaves. "The knowledge their tribes have accumulated about the medicinal properties of the plants is incalculable. Gaining their trust, allowing us to share in that, it's like entering Fort Knox."

Such local knowledge about plants has led to crucial medical discoveries. Hundreds of years ago the native people of the Andes identified quinine, found in the bark of the cinchona tree, as a treatment for malaria. And at least 11 North American tribes understood that they could relieve pain with extracts from the willow tree, which led to the formula for aspirin.

Conservation International believes that Suriname, 80 percent of which is covered by rain forest, may hold similar discoveries among its thousands of plant species still unstudied by Western scientists. The apprentice program calls for the profits of any drug discovered to be shared with the indigenous community that helped identify it.

Programs like this are a change of tack for Suriname, a South American republic that has struggled greatly since gaining independence from the Netherlands in 1975. The country has endured a military dictatorship, civil war, and the collapse of both Dutch aid and an economy based almost entirely on bauxite, a reddish ore used to make aluminum. It still struggles against drug trafficking and illegal gold mining. By 1994 the country was so strapped for cash that it was considering selling off up to 40 percent of its forest to Asian logging concerns.

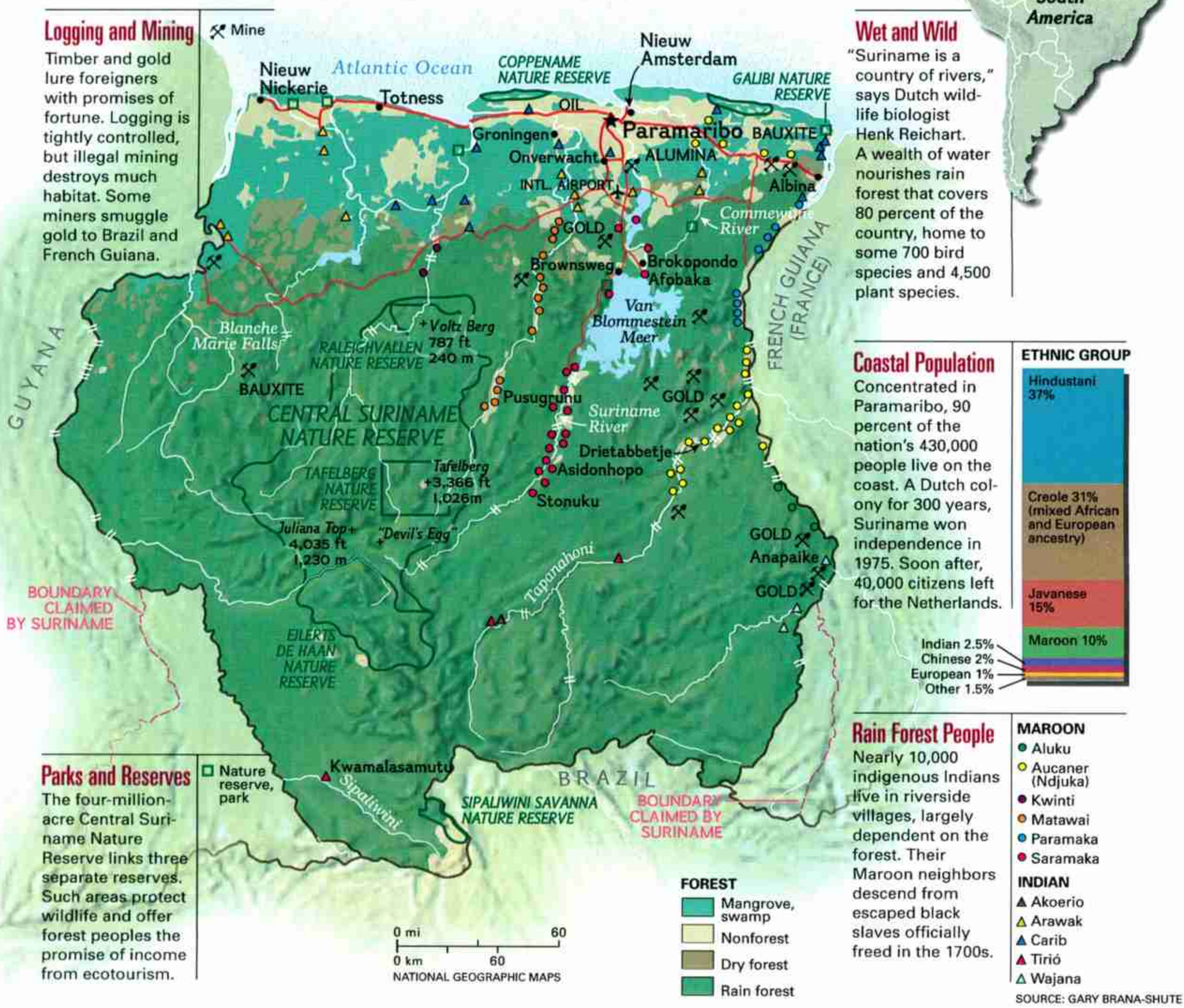
While some logging occurs in the north, loss of that much forest would have endangered hundreds of animal and plant species. It also would have posed a threat to the country's forest people: five groups of Indians and six groups of Maroons, descendants of escaped slaves who won their freedom in the 1700s.

It is understandable why, in such bleak circumstances, Suriname considered selling its forests wholesale. But after conservationists showed that profit from logging firms would



Under a tropical sun the influence of the Netherlands radiates from the capital city of Paramaribo. In the 1600s French, British, and Dutch settlers in turn developed the Atlantic port. Today Creoles live among Hindustani, Javanese, and Chinese descendants of indentured servants who never returned home.

SURINAME: A Forest of Riches



be negligible and proposed long-term commercial alternatives, the government agreed to nix the deals. In a dramatic gesture Suriname and CI announced in 1998 creation of the Central Suriname Nature Reserve, a protected area that covers 10 percent of the country.

With the aluminum industry having rallied a bit in recent years, Surinamers can afford to ponder other ways to develop their rain forest. One avenue may be new medicines. Another may be ecotourism, which has proved to be profitable for tropical countries like Costa Rica. Recently the Inter-American Development Bank approved a 1.38-million-dollar assistance package to Suriname so it could continue to explore an ecologically sound course of development. By saving a significant portion of its forest from the chain saw, Suriname has at least bought itself time.

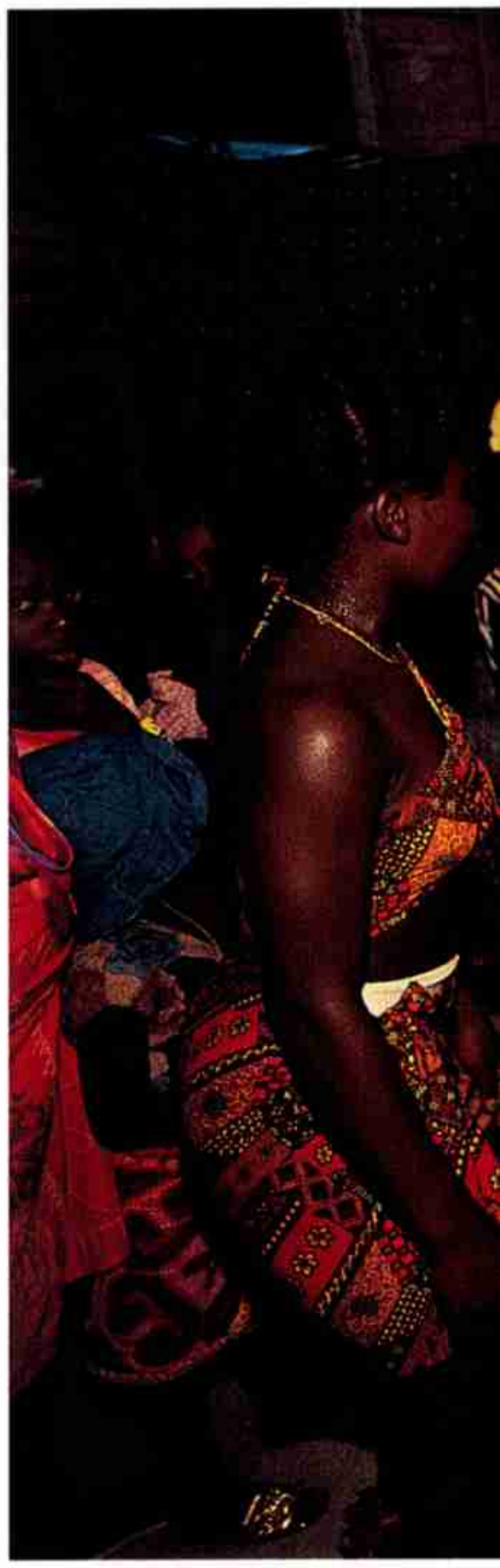
BECAUSE OF ITS RICH MIX of people and language and the isolation of the forest people from those on the coast, Suriname is difficult to define. Ninety percent of Suriname's population of 430,000 lives along a narrow strip of fertile land that stretches along the Atlantic coast. Here people

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"In the name of Allah, the most merciful," pray Javanese Muslim women marking the end of the month-long fast of Ramadan. Brought in by Dutch landowners after the 1850s, the Javanese worked Suriname's sugarcane fields as indentured servants until World War II.







Drums create a dancing mood at a festive party in the village of Drietabbetje (right). Retaining much of the art, language, and rituals of escaped slave ancestors, Suriname's Maroons, or Bush Negroes, as they call themselves, have been free since the 1700s.

Deep in the rain forest, a Tirió Indian woman cooks a traditional meal: cassava and monkey, roasted till tender.

of African and European ancestry live alongside the descendants of people from China, India, and Indonesia. Tolerance is the rule, and marriage between groups is common.

Suriname's capital, Paramaribo, reflects this diversity. Mosques and synagogues stand next to Hindu temples. Music is heard everywhere, and it is as varied as the people—reggae, Hindi film songs, Surinamese Afro-pop.

While the air of the city is cosmopolitan, it is anything but South American. The language of the schools and media is Dutch. When Surinamers think of the outside world, their eyes do not turn to Caracas or Buenos Aires or even Miami but rather to Amsterdam. Enclaves of European café culture endure, where locals linger over a glass of beer or a cigarette, looking at nothing except the heat rising from the asphalt of an empty plaza surrounded by clapboard buildings badly in need of a coat of paint. At night the hip and the young gather to drink rounds of Heineken at a bar called Leidseplein, named after the square in Amsterdam that is a popular hangout for Dutch teenagers.

But European culture is by no means the dominant one here. By the water's edge most mornings there is a convergence of Indian bazaar, African marketplace, and Caribbean carnival. Creole and Javanese hawkers vociferously push their fresh produce in the litter-strewn lane that winds between concrete structures. Chinese shopkeepers sell everything from detergent to glasses of rum. Hindustani taxi drivers lean on the hoods of Japanese cars, which look as if they've been brought back from the dead, and chat in Sarnami, a form of Hindi.

Though the atmosphere of their largest city is decidedly festive, most Surinamers came to the former Dutch Guiana under less than happy circumstances. When the Dutch (who had swapped Nieuw Amsterdam—present-day Manhattan—for the colony in 1667) abolished slavery in 1863, they still needed cheap labor for their faltering sugar plantations, so they turned increasingly to indentured laborers from China, India, and Dutch colonies in Indonesia.

Louis Autar's mother came to Suriname from Java as an indentured laborer when she was 15. Autar, who until his recent death was one of the world's most recognized authorities on Suriname's giant sea turtles, was born on a

Music is everywhere. Reggae, Hindi film songs, Surinamese Afro-pop.



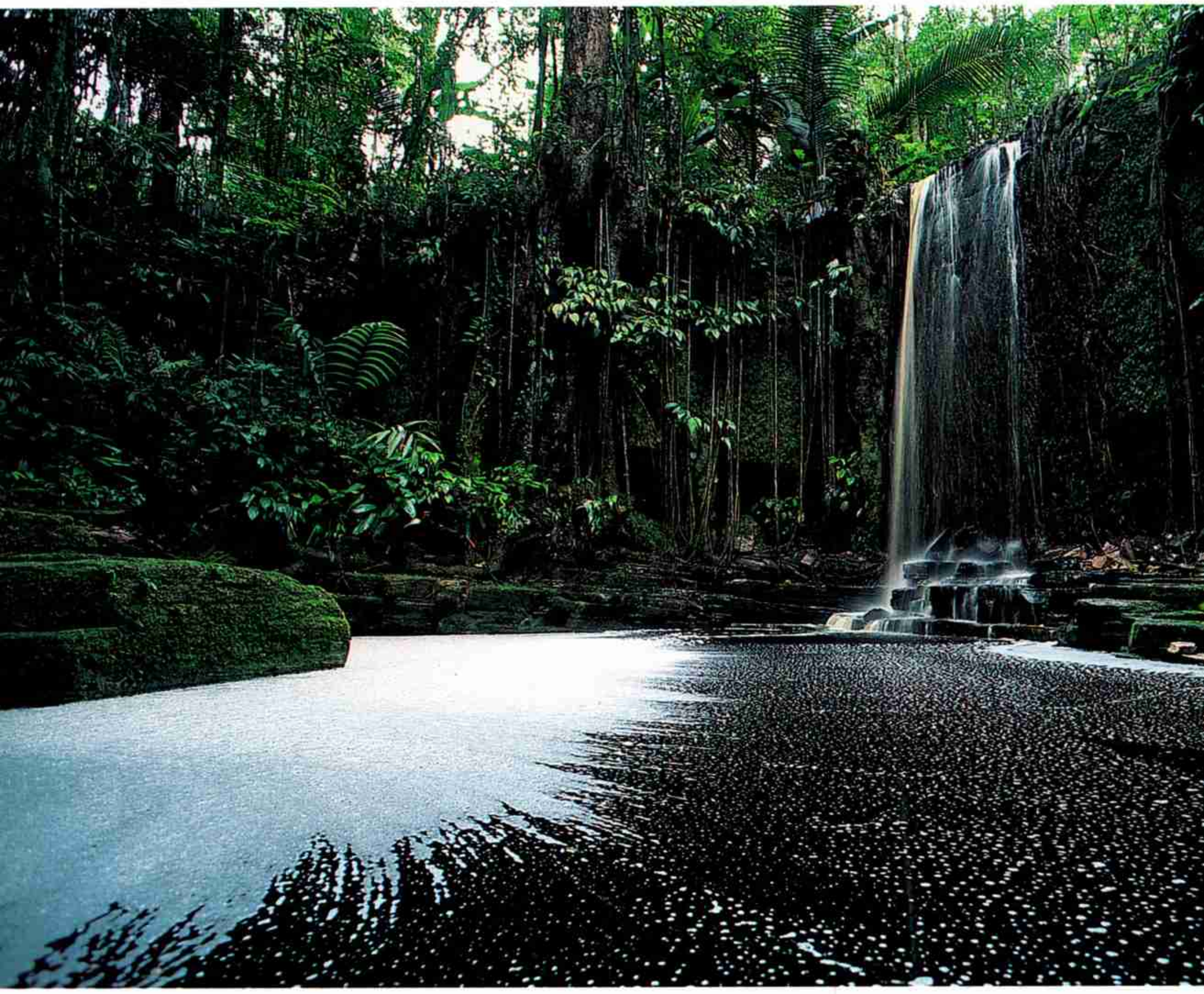
plantation on the Commewijne River called Het Vertrouwen, or "trust." Despite the benign name, life there was full of hardship.

On the outskirts of Paramaribo, Autar and I sat on plastic chairs in his driveway, drinking orange soda, chatting about the old days. He alternately spoke in Dutch, English, and Sranan Tongo—a creole as commonly spoken as Dutch. "In 1917, after eight years as a contract laborer," he said, "my mother decided to stay on here and to buy three small parcels of land. She'd saved the money working for 40 cents a day on the plantation. It was a tough life. There was no electricity; we had only rainwater to drink. When I was born, it was the dry season, so there wasn't even any rainwater. My mother had to bathe me in seawater."

Autar had been a good student, but his parents could not afford to send him to high school, so at 14 he went off to the coast, where he began to work as a poacher, stealing the eggs of the leatherback turtle to sell to the Javanese of Paramaribo, who consider them a delicacy. It was there, many years later, that he was arrested by the Dutch for poaching.

That same day, the authorities offered him a job with the Forestry Department, then one of the best in South America. "They couldn't believe I knew so much about the sea turtles," he said. "I was able to make much more money caring for the eggs than I had been selling them off. The department gave me money to build a nursery. In all I returned 16,000 sea turtles to the sea. After independence, when the military

"We want to live in a healthy environment. But we want to eat too."



took over, there was no more money for conservation. The sea came in. Now my nursery is just a mud bank."

WHILE DUTCH RULE during the days of the plantations had often been harsh, in more recent times it was so generous that the colony came to enjoy the highest standard of living in South America. Indeed, at the time of independence, there was so much pessimism about a future without the Dutch that 40,000 Surinamers, nearly half the workforce, chose the option of Dutch citizenship and moved to the Netherlands. Many who left were from the professional classes, and the brain drain worsened an already bad economy.

Among those who eventually opted for life in the Netherlands was Roy Tjin, a Surinamese photographer of Chinese descent, who was back for a visit and took me one evening to meet his friend Agnes Chandansingh in her posh Paramaribo neighborhood. Chandansingh's mother was a Hindu, her father a Roman Catholic, and, like many Hindustanis, they worked hard and saved, helping to make their community the most economically stable in the country.

Still, things in Suriname are not as Chandansingh would like them to be—or as they once were. "We have so many resources, and so few people. But still we're poor," she said as we sat in her garden beneath a full moon, drinking tea. "Since independence, I've actually seen people grow poorer."





A primordial peace washes over a waterfall near Tafelberg in the Central Suriname Nature Reserve (left). Low human impact helps keep streams in the area pristine.

Out of harm's way, a leatherback turtle (above) buries some 80 eggs in the sand at Galibi Nature Reserve, haven for four sea turtle species. Poachers hunt their eggs to sell as aphrodisiacs.

There was a heavy silence as we finished off the tea. At last Tjin said, "Before independence a civil servant could afford a house, a car, one trip to Holland a year. When we look back at all that now, we realize that it was then that things were abnormal, not now. The past was too good to us."

We spoke of Suriname's renewed interest in conservation. Chandansingh just sighed. "Of course we want to live in a healthy environment. But we want to eat too."

Coastal attitudes toward the jungle interior are perhaps best symbolized by the images on Suriname's bank notes: On the back of one is a fine-lined sketch of a bit of logging; on another is a scene of some strip mining. The official message from the coastal capital long seemed to be that rapacity was equal to progress.

"People on the coast are afraid of the interior," said an American who grew up in Suriname. "For them the rain forest is all about mosquitoes; the interior is danger." He added that very few people from the capital have actually been there. "After all, it's cheaper to fly to Miami than it is to charter a plane to Kwamalasamutu."

But a significant shift has begun in the way coastal people view the interior. I saw signs of this change in Paramaribo, when I met Paul Abena at the radio station he had established. Abena calls his station Radio Koyeba, short for *kon yere ba*, which in the language of his people, the Aucaner Maroons, means "come and hear, brother." He received me graciously, offering beer in a plastic cup, and led me to a small room where we sat at a narrow table. A lanky man with headphones, a turntable, and a mike sat deejaying a radio broadcast.

Abena, a deeply earnest man, summed up a view that I saw throughout the country. "My philosophy is that someone else cannot do something for you as well as you can do it yourself."

Abena entered a career in broadcasting, eventually becoming the first Maroon anchorman on national Surinamese television. "What was lacking in Suriname," he said, "was a form of communication between the people of the coast and the people of the interior."

Through Radio Koyeba he has established such a communication. Abena is now broadcasting music and information throughout the country 19 hours a day, seven days a week, in two Maroon languages and two Indian

Symbols of his rain forest world fill Wuta Wajimuu's freehand map of the Tirió people's western territory. Drawn from collective memories and expeditions, it inspired Suriname officials and conservation groups to help the Indians create a scientific version. The Tirió hope that the government will one day grant them title to land they have occupied for centuries.



"Their knowledge of the medicinal properties of the plants is incalculable."



languages as well as Dutch, French, and English.

All of Abena's staff are from the interior. "None of them had any experience in radio," he told me. "But we all believed very strongly that communication can educate and unite. As someone who was born in the interior but raised here in the city, I wanted to be able to build a bridge between the two places—a bridge that everyone could traverse."

THE BRIDGES connecting the coast and the interior are indeed few. There are only four main roads out of the capital. The ribbon of red earth I took ran 60 miles south to Brownsweg. After that, as I was to discover, you're no longer in a world of signposts.

Jan Meyer, an ethnobotanist of Dutch and Javanese parentage, and I had set out for Asidonhopo. That is the seat of the Saramaka and the largest settlement of Maroons in the country. After beginning our journey by truck, we continued on the Suriname River in a dugout with an outboard motor strapped to its hull.

Little yellow butterflies skidded just above the surface of the thick, brown river. The sky was low and full of clouds, some heavy with rain, others full of light. The river curved endlessly, and at almost every bend we descended rapids that churned where the current folded under and onto itself. On either side of us lay thick, green forest, outlined here and there by a tiny strip of immaculate beach. Heavy





How much logging is too much? The government and conservationists debate the question even as trucks haul hardwood near Afobaka (left). Though cash poor, Suriname practices restraint in granting logging permits. Conservationists champion another path to profit: medicinal plants. Some can soothe an earache (above). Others might lead to breakthrough cures.

branches drooped, casting shadows on the water's edge.

Eventually we began to see signs of Maroon settlement—a few steps leading to glimpses of thatched roof in the tangle of the bush. Then we began to see people fishing, bathing, and tethering motorized dugouts to the roots of trees. My eyes began to adjust to the jungle, and I could make out more of the villages that lay hidden inside: zinc roofs alongside the thatched ones, beaten dirt paths, indistinct human forms.

Invisible birds—thousands of them, it seemed—sang from the green fastness of the jungle. I lay back in the boat and concentrated on their song, rising and falling in a high-pitched, faraway chorus. But soon I heard voices shouting in Saramaccan from the sides of the river—throaty cries of protest. Meyer translated: "They're saying, 'If that white man is still alive, tell him to sit up. Only dead people lie down in boats.'"

For their survival, Maroons rely upon the forest. Individual villagers have their own houses—small wood structures with peaked roofs that are just big enough to sling a hammock under—and their own dugouts, which they use to travel to their own agricultural plots. They supplement their garden diet by fishing and hunting.

Despite the remoteness of their villages, Maroons have always been dependent on certain goods from the coast. Their raids on the plantations not only brought about the treaty that made them among the first freed blacks in the Americas but also contributed to the bankruptcy of many plantations. From such raids they came home with essential goods like guns and axes—as well as women.

Throughout the village I noticed many items from the coast. Although these objects were modern, their uses were timeless—a plastic bowl carried on the head, a beach towel worn as a sarong, umbrellas proudly displayed as walking sticks.

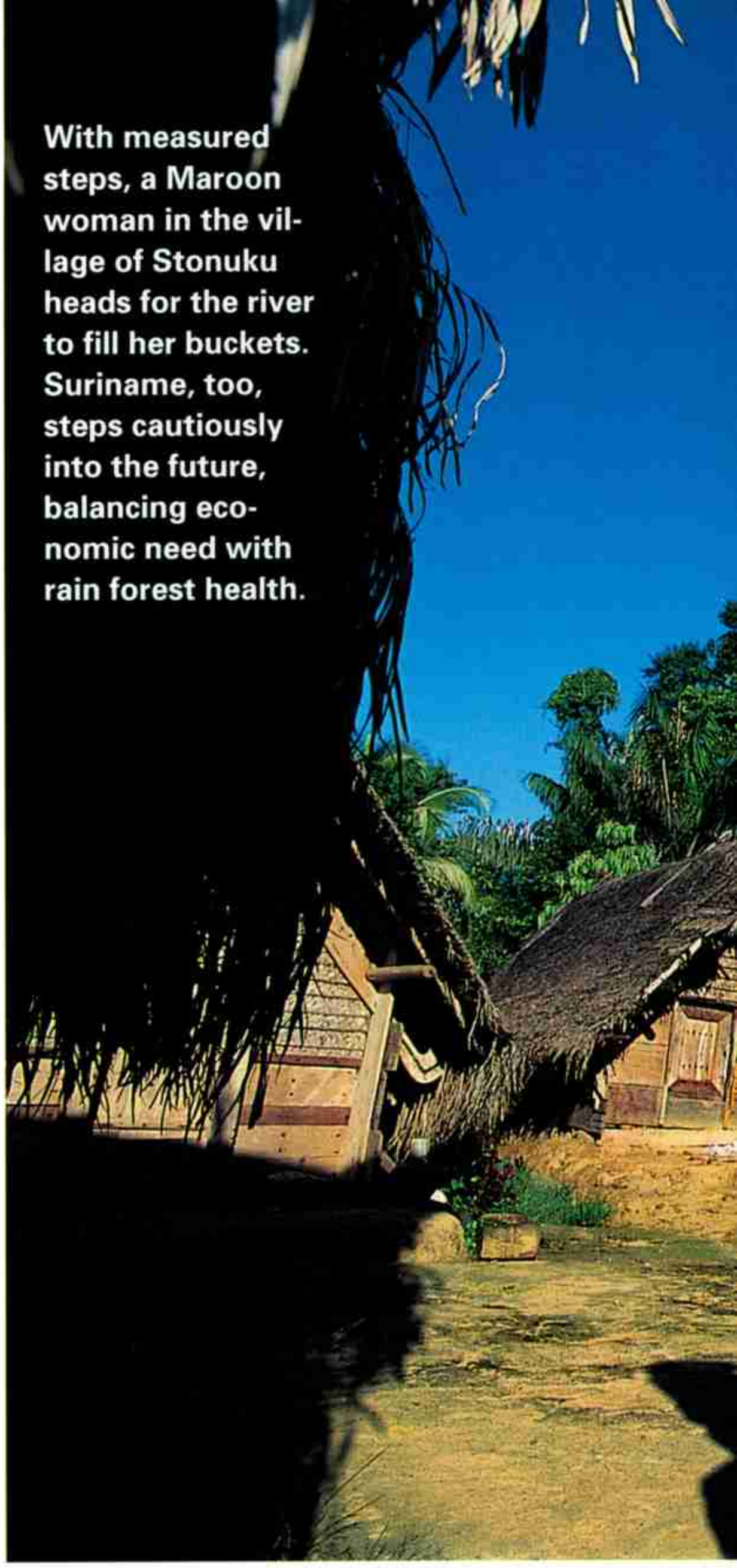
Sitting in the shade of a grass roof supported by four poles, Afoisa Pansa, 70, and his cousin Zozo were carving cedar with pen knives. Pansa showed us a small, round table the size of a salad bowl that he'd just completed. Its surface was embellished with fluid spirals and graceful concentric circles that he told me were symbolic of love and embraces.

Like so many things in this matrilineal

society, the craft of wood carving was passed on to Pansa through his mother's relatives. But Pansa is an artist with his own style. "I was taught some basic designs when I was little," he said, "but I don't just copy what carvers before me did. I see beautiful things in the forest—shadows and vines and river whirlpools—and I put them into my carvings."

Most of the older houses in the village, I noticed, were elaborately carved with squares, dashes, lightning bolts, and other designs, but many of the newer ones were not. Carvers used to embellish people's homes in exchange for other goods and services. But in recent years the old barter economy of Maroon society has become increasingly cash based. There are almost no jobs in the bush, so young men and women travel to Paramaribo in search of work.

I asked Pansa if he was passing on this craft as it was passed on to him when he was young. "I'm teaching my nephew and another boy," he replied. "Most of the boys weren't interested. I tell them it's good to learn wood carving because it keeps our traditions alive. Also, it's a way to make money right here in the community. Now we have tourists coming here sometimes, and they love my carvings so much they pay money for them."



With measured steps, a Maroon woman in the village of Stonuku heads for the river to fill her buckets. Suriname, too, steps cautiously into the future, balancing economic need with rain forest health.

THE TIRIÓ INDIANS and other tribes share the Maroons' isolation and lack of employment opportunities. But they also share a similar deep respect for their own traditions. This was apparent to me as soon as I had landed in Kwamalasamutu, the settlement near the Brazilian border where I would watch the shaman and his apprentice.

The prop plane deposited me and a team from Conservation International into a clearing in the rain forest a short hike from the village itself. Had we chosen to travel here overland from Paramaribo, as the Tirió Indians sometimes do, the trip would have taken a month.

I was immediately led to meet the chief of the Tirió, who would decide whether or not I could stay. If he denied me permission, I would be obliged to stay in a hut, making contact with no one until the plane came back days later. We sat on one side of a long table on the veranda of the concrete structure in the middle of the village where *krutu,* or official meetings, take place, staring at the chief's empty chair. Doors painted in jarring reds and blues and yellows stood on either side of us. Behind one, the two most valuable possessions of the village were kept: a shortwave radio and a generator-powered freezer. Behind another was the punishment room, where those who break traditional law must sit for four days with their thumbs tied to their toes.

At last the chief arrived, and we all sprang to our feet. He was a middle-aged man, short and portly, wearing a cotton dress shirt, a pair of cotton slacks, a digital watch—and an enormous headdress about three feet high: White, brown, and orange feathers rose from his head; long feathered tresses hung on either side of his bronzed face.



I was introduced. The chief listened carefully, repeating my name and the name of this magazine, as if to commit them to the collective memory of the village. At last the big brown bag of school supplies I had brought as a gift was set between us. The chief opened the bag and inspected the rulers, pens, compasses, and boxes of chalk, nodding graciously.

"Your visit should be of mutual interest," the chief said. "This is the way of the Tirió. I am grateful to you for your gifts. Now we will take care of your needs."

In the language of the Tirió, this concept of reciprocal help—a kind of "you scratch my back and I'll scratch yours" philosophy—is known as *e-pah-wah-nah*. It has been the glue of Tirió society for thousands of years, and it has withstood many tests, from the invasion of Europeans in the 1600s to Christian conversion by a Baptist missionary in the 1960s.

It is a worldview that has become increasingly common among all Surinamers. No longer able to depend upon the largesse of the Dutch, Surinamers realize that they must depend upon one another if they are to move forward. In the end, it may be that the wisdom of the forest—the medicinal knowledge and the traditional concept of self-help—is the only alternative for a young nation anxiously in search of itself. □

PILGRIMAGE THROUGH THE SIERRA

BY PAUL SALOPEK

Sparks scratch fiery calligraphy in a timeless mountain night as Tarahumara Indians celebrate Easter in the Sierra Madre Occidental. Such scenes would have been familiar to the brilliant, enigmatic loner Carl Lumholtz, who rode into Mexico's mountains a century ago. Among the last of the great Victorian explorers, Lumholtz hoped to pry secrets from an ancient, raw frontier. The author, riding by mule along 1,300 miles of the explorer's route, learned that Lumholtz's greatest discoveries lay elsewhere—in the depths of the human heart.



MADRE

PHOTOGRAPHS BY MARIA STENZEL



Sheltered from the centuries, pre-Columbian ruins stand forgotten in a remote canyon in Chihuahua. A vain hope lured Lumholtz to Mexico in 1890: He believed the ancient culture of the Anasazi, famous cliff dwellers of the American Southwest, held out in the Sierra Madre.

Unlike countless other escapists we head south not to forget but to try and recapture what has already vanished.

My journey begins on a desert morning in May when the air is like glycerin, so clear it magnifies the world. I unload a newly bought $300 mule from the back of a friend's pickup truck and spur him south from Mexico's border-hugging Highway 2, near Agua Prieta, Sonora.

Rivers and fences permitting, I will retrace Lumholtz's route down to where the Sierra Madre unravels at the Río Grande de Santiago some 900 miles away. If I am still able, I then will ride on to the central Mexican state of Michoacán, where Lumholtz sold his mules and hopped the train to Mexico City. Lumholtz made this grand traverse in four trips totaling five and a half years. I give myself nine months.

My cowboy friend Chico Tellez's pickup shrinks into a squiggly dot in the heat waves of distance. I give the mule a pat and wheel it toward the weightless blue peaks floating on the horizon.

Then it bucks me off, and breaks my nose.

Climbing, climbing, climbing, one massive cordon after another, at the start through dense oak thickets, and over hills flattened and eroded with countless deep, precipitous gashes seaming the rock in every direction.

Lumholtz plunges into Mexico's unruly *ocean of mountains* with the zest of a medieval navigator seeking the edge of the world. His expedition raises a smear of dust across the brittle autumn grasslands: 29 packers and museum scientists herd scores of mules loaded with luxuries such as honey and dried peaches, canvas tents, an arsenal of guns, folding camp furniture, and a personal library crated for hard travel. The motley party hacks its way across scrubby, waterless valleys and up wooded mountain passes—the final redoubts of the world's last free-roaming Apache. Not a single living Anasazi, of course, is found.

Instead Lumholtz discovers the mysterious remnants of another bygone people—the Mogollon. And following the traditions of his day he excavates everything. Indian pottery. Mummies. Grinding stones. Ancient yucca-fiber sandals. Even the bones of Apache killed in a battle with Mexican settlers.

What the rural Mexicans make of this manic collecting is hard to guess. But they crowd around Lumholtz's tent at night *as if an auction had been going on inside,* trying to fit him into their universe:

They were all anxious to have me feel their pulse, whether there was anything the matter with them or not. They firmly believed that this mysterious touch enabled me to tell whether they were afflicted with any kind of disease and how long they were going to live.

Thus, Lumholtz becomes El Doctor, a traveling healer.

A century later I have no such alibi. Threading my way along lonely ranch roads and faded horse trails, I am taken for a geologist searching for lost gold mines, a gunrunner, a rural schoolteacher, and a wandering Mormon from the community of Colonia Juárez, Chihuahua. At first I try being honest. I spread out my maps; I pass around my copy of *Unknown Mexico,* its pages grimed by dozens of rancheros' hands. Yet the Mexicans snort in disbelief. Such elaborate props can only mask a more dramatic, perhaps more sinister truth. So I begin shaping my story to ease my passage. I tell them I am transporting a big Sonoran mule from village A to village B. (True.) That I am searching for a long-lost friend. (True.) That I am on a pilgrimage. (Truest of all.)

But one afternoon in a hot, desolate, rocky draw in Sonora, even these glib evasions fail. Three drug traffickers—*narcotraficantes*—stand around my little heap of books and maps, weighing whether to kill this ignorant foreigner who has blundered into their canyon on muleback. They are stripped to the waist, sweating profusely, and one of them has a gun. Dead Norwegians cut no ice. What's more, their own secret lies exposed around us—thousands of sprouting marijuana seedlings. And they are waiting. So I save myself. I tell them about my father.

LUMHOLTZ
made this grand traverse in
five and a half years.
I give myself nine months.

EVEN IN MY EARLIEST memories, my father is talking; he is always talking. I am perhaps five, sitting in the back seat of the family Studebaker, and he is cruising the streets of southern California stumping for Bobby Kennedy. The megaphone on the car roof makes my bones vibrate.

When Bobby is shot in 1968, my father quits his job as a graphic illustrator, sells our house on Virginia Way, and drives my mother and us kids into Mexico. He has no clear destination in mind. He doesn't speak a word of Spanish. This bewildering, unilateral act of defiance becomes the continental divide in my life. Why Mexico? My mother claims not to know. But it is a decision that will forever relegate her children to that melancholy subclass—the stateless, people of questionable allegiances.

Six years later, after my father dies, we retreat to the United States, and there, in the snow-muffled town where we settle, my three souls begin wandering in earnest. The suburban smell of burning leaves conjures the torched winter cornfields of the central Mexican plateau. Snatches of a Spanish song on the radio can unlock, if I let them, a whole world of cobblestones, subtropical rains, and heavy copper coins. Perfect blue volcanoes crowd my dreams. It is as though a place could be a parent. As if by returning, I somehow could belong again. But this is an illusion.

"Where are you from, blondie?" the sierra's campesinos ask when I stop for directions at their corrals and log cabins. My rural Mexican accent confuses them. The long vowels, like water sloshing in a gourd, are too authentic, and I am too gringo.

"*Del otro lado,*" I reply, "the other side," meaning the United States, but really meaning much farther than that.

The drug traffickers are human. They don't shoot me. They send me away with a warning, down a mountain trail that, like many in the Sierra Madre, leads nowhere.

Carl Lumholtz knew all about cultural alienation. This is one reason I seek him out: to interrogate his kindred solitariness. Born the son of a Norwegian army officer near Lillehammer in 1851, young Lumholtz stands apart at an early age, a strange boy with an unsettling, watchful gaze; a lover of wild places who spends hours tramping through the forested mountains of Norway. While still a schoolboy he amasses a botanical collection so professional it ends up at the prestigious Royal Botanic Gardens at Kew in England. But science prodigies are of no account in the pious, hidebound world of rural Norway. His father wants a priest in the family.

Miserably, stoically, Lumholtz stows his plant presses. He burrows into theology school, burning candles through 16-hour days of prayer and study, spiraling toward the defining disaster of his life. Stifled by the regimented life of the clergy, exhausted by the heavy workload, his resolve weakens, frays—finally snaps. He suffers a nervous breakdown. He is never ordained.

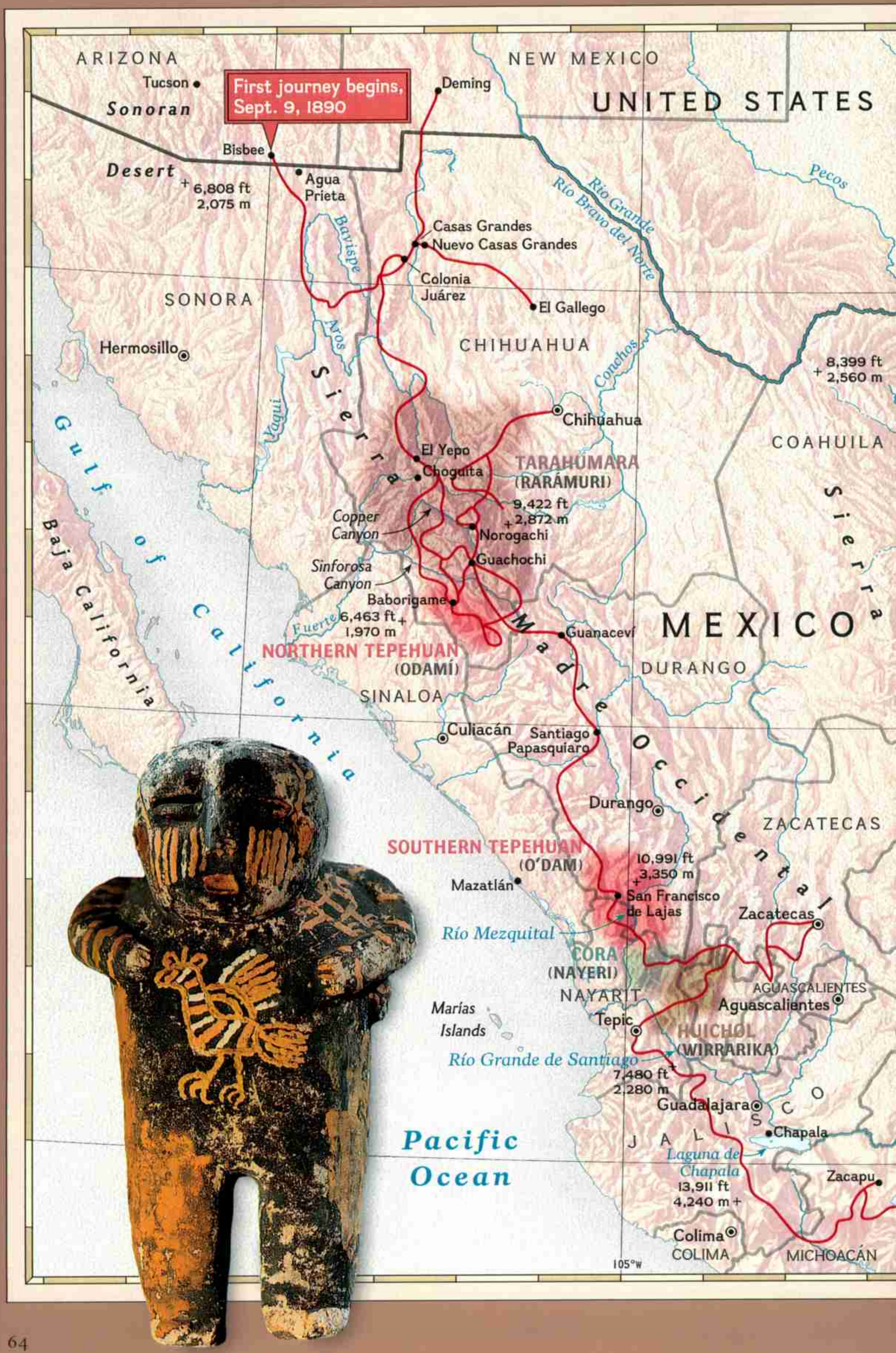
To regain the stability of my nerves, the explorer will recall many years later, *I now devoted myself exclusively to the collecting of birds and animals and to a study of their modes of life.*

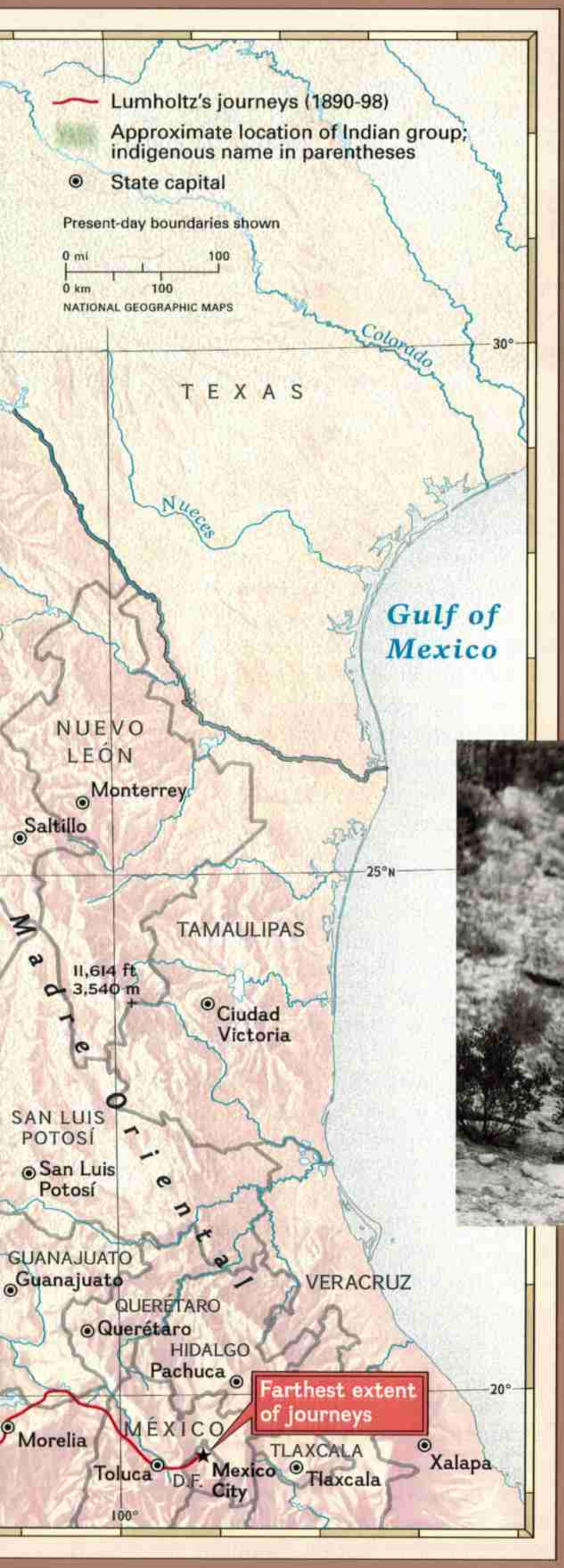
These rare lines of self-revelation, cocooned as they are in Victorian reserve, still quiver faintly with emotional hysteria. To recuperate, Lumholtz takes long walks in the woods, but simple things, like the beauty of willows reflected in mountain pools, move him to tears. He writes: *Love of nature took stronger and stronger hold of me and one day it occurred to me what a misfortune it would be to die without having seen the whole earth.*

Lumholtz will turn 29 before acting out these yearnings. Equipped with a revolver and the blessing of the University of Christiania in Oslo, the failed seminarian sails in 1880 for the sodden jungles of Queensland, Australia, where he spends four years shooting specimens for European museums (his bag includes a previously unknown mammal, a tree kangaroo) and roughing it with Aborigines. This swaggering adventure spawns his first book, *Among Cannibals,* and highlights Lumholtz's two often contradictory trademarks as an explorer: a hard-nosed compulsion to describe everything he encounters with scientific accuracy and an almost dreamy fascination with *savage and barbaric races.*

Such racist language betrays the cultural pretensions of Lumholtz's day, but the peoples of the sierra would chip away at that Victorian arrogance. One thing, however, will never change: his essential isolation.

Lumholtz now charms expedition funding from the pockets of such glitterati as the


ARIZONA
NEW MEXICO
UNITED STATES
Tucson
Sonoran
Desert
First journey begins, Sept. 9, 1890
Bisbee
Agua Prieta
+ 6,808 ft 2,075 m
Deming
Río Grande
Río Bravo del Norte
Pecos
Bavispe
Casas Grandes
Nuevo Casas Grandes
Colonia Juárez
El Gallego
SONORA
CHIHUAHUA
Hermosillo
Sierra Madre Occidental
Yaqui
Aros
Conchos
8,399 ft
+ 2,560 m
Chihuahua
COAHUILA
El Yepo
Choguita
TARAHUMARA (RARÁMURI)
9,422 ft
+ 2,872 m
Norogachi
Copper Canyon
Guachochi
Sinforosa Canyon
Baborigame
6,463 ft +
1,970 m
Fuerte
Guanaceví
MEXICO
NORTHERN TEPEHUAN (ODAMÍ)
DURANGO
SINALOA
Culiacán
Santiago Papasquiaro
Durango
ZACATECAS
Gulf of California
Baja California
SOUTHERN TEPEHUAN (O'DAM)
10,991 ft
+ 3,350 m
Mazatlán
San Francisco de Lajas
Zacatecas
Río Mezquital
CORA (NAYERI)
NAYARIT
AGUASCALIENTES
Aguascalientes
Marías Islands
Tepic
HUICHOL (WIRRARIKA)
Río Grande de Santiago
7,480 ft
2,280 m
Guadalajara
Chapala
JALISCO
Laguna de Chapala
13,911 ft
4,240 m +
Zacapu
Colima
COLIMA
MICHOACÁN
105°W
Pacific Ocean





Unknown Mexico

"An ocean of mountains" is how Norwegian explorer Carl Lumholtz described Mexico's 900-mile-long Sierra Madre Occidental. Lumholtz (below) criss-crossed the vast range by mule, collecting thousands of Indian artifacts, from Huichol idols (facing page) to Casas Grandes pots (above).

Setting out from Arizona Territory with 29 men—scientists, packers, guides—Lumholtz soon whittled his party down to a few Mexican and Indian muleteers. He pushed south through the Sierra Madre in three separate expeditions from 1890 through 1897 and returned briefly in 1898. His written record, a 1,026-page travelogue, Unknown Mexico, *was an early, impassioned call for ethnic tolerance and Indian rights.*



Carnegies and the Vanderbilts, but his personal correspondence, yellowing letters stored in cabinets at the American Museum of Natural History, gives no hint of close friendships. He will christen mountains and water holes after a succession of women friends. But he will never marry. He becomes instead *a man who comes from far away,* a constant stranger.

"Oh, he had his tics," says Ludvig Lumholtz, the explorer's 87-year-old grandnephew. "He was into strange diets—holistic foods and that sort of thing long before they became popular. One egg for breakfast. Honey in his coffee."

I reach Ludvig by phone at his rural home in England, and there is something about his voice—an antique courtliness, an accent like well-oiled mahogany—that seems quintessentially Lumholtzian. A former British colonial officer, Ludvig handles personal questions warily. He allows that he met his granduncle once as a young boy, in 1920. Yes, he still owns the great man's Norwegian Geographic Society medal. And no, he doesn't know what drew the explorer's restless gaze toward the Americas.

Yet Lumholtz himself tells us. There are people there who are even more jealous of their independence and enthralled by wild nature than he. The Indians.

I HAVE RIDDEN 400 MILES into the sierra, hauling the mule across the Río de Aros in my underwear, sleeping under rock overhangs, when I meet José Merino. He stands bowlegged atop a remote mesa, his feet strapped into tire-soled sandals, talking about hotels.

"They want to build one here," says Merino, the *gobernador,* or traditional Indian authority, of a nearby Tarahumara village called Norogachi. He is talking about the outside world's latest cure for the chronic ailment plaguing his people's vast, rugged homeland: economic backwardness. The Mexican government is planning a lot of hotels—nearly 4,000 rooms' worth. Add 500 camping sites and 1,500 trailer spaces, plus all the attendant roads, power lines, dams, airports, and sewage-treatment plants necessary for 500,000 mostly American tourists a year, and you have the latest scheme for bringing prosperity to one of the poorest, dustiest corners of the Sierra Madre.

"Maybe we need a hotel here, maybe we don't," Merino hisses, squinting out over thousands of acres of brittle junipers. He pauses, drops a ball of spit onto the dust, and adds, "Our problem is, nobody asked us."

The entire recorded history of the Tarahumara—70,000 reclusive farmers who churn their fields with oaken plows, speak among themselves in a birdlike Uto-Aztecan tongue, and dance for days to please a deity associated with both the Christian god and the sun—can be summarized in that one phrase: Nobody asked us. Not the silver-crazed Spaniards who showed up in the sierra 400 years ago. Not the stampede of loggers, dope growers, and backpackers who have followed since. Not, most recently, the bureaucrats behind the 385-million-dollar ecotourism proposal dubbed the Copper Canyon Master Plan. And I too am uninvited.

I find Merino among a large, milling crowd of Indians gathered on the mesa for a traditional Tarahumara ball race. When the old man learns I am not a state functionary—that his complaints about the impending invasion of hoteliers are wasted—he grimaces with disappointment and simply walks away. Other men, wearing white cotton loincloths, stare sullenly at the ground as I pass. The women are more energetic in their aversion. They hide behind trees.

This deep, abiding mistrust is the Tarahumara's last defense against encroaching Western civilization, and Lumholtz knew it well: *As I travelled along I found the natives unobliging and afraid of me,* he reports laconically when Indians scatter from their villages at his approach.

Yet the Norseman perseveres, beguiled by the tough, deeply religious people that the Mexican settlers curse as lazy, unkempt savages. In order to move among them with greater ease, he even discharges most of his cooks, packers, and scientific entourage in the spring of 1892.

It is while sharing what little they have—they are a people with a few clay pots, a basket, a rough-spun blanket—that a surprising spark of empathy arcs between the rootless European and the taciturn Indians who are becoming exiles in their own land.

There was a kind of noble bearing and reserve about them which even the long contact with condescending whites and half-breeds had not been able to destroy, Lumholtz notes with

admiration. *The almighty dollar has no devotees among these Indians. They have no need of aught that money can buy, and are swayed by persuasion and kind and just treatment more than by gold.*

In the end Lumholtz will spend 18 solid months holed up in the rugged uplands of Chihuahua, recording the Tarahumara language and sacred songs, drinking corn beer, and unveiling the rich tapestry of culture hidden behind the Indians' austere existence. At one feast he watches a young woman wooing a prospective husband.

She tries to attract his attention by dancing in front of him in a clumsy way. But so bashful is she that she persistently keeps her back turned toward him. She may also sit down near him and pull his blanket and sing to him in a gentle low voice a simple love-song:

Se-(se)-ma-te re-hoy i-rú Se-(se)-ma-te re-hoy i-vá—Beautiful man to be sure, Beautiful man to be sure.

THE WOMEN
are more energetic in their aversion. They hide behind trees.

Modern anthropology gives a name to the intimate relationship the explorer cultivated with the Tarahumara: Lumholtz became a "participant-observer."

"Lumholtz virtually invented the technique," says Jesús Jáuregui, a leading Mexican expert on the peoples of the southern Sierra Madre. "At the time, Victorian ethnologists were into building simple hierarchies of human culture with a few scattered anecdotes.

"Then this strange Norwegian came along and lived for long periods of time with Indians, learning their true complexity," says Jáuregui. "He accomplished a rare thing. He *lifted* that mask Indians wear in the presence of outsiders."

A century later I try to do the same. If the Apache were among native America's finest horsemen, then the Tarahumara, who call themselves Rarámuri, or foot runners, are its born ultramarathoners. They kick wooden balls for scores of miles across lung-busting terrain. But these are more than athletic feats. The runners draw together a scattered, besieged community in their wake. They give the Tarahumara a reason to celebrate in unforgiving times—not to mention a chance to gamble.

After placing 50 pesos on a wiry, long-legged champion from Norogachi named Fernando, I trot off at dusk with a mob of his whooping supporters, jogging across the mesa under a bone-white moon. Fernando glides over rocks and creeks at a shuffle, his deer-hoof belt clacking out a steady tattoo. Dozens of us straggle behind, men and women holding pine-heart torches aloft, others spotting the ball with flashlights.

Then—a simple gesture in the darkness: A Tarahumara running alongside me passes his cigarette. I accept. And for the next five glorious hours—about one 25-mile circuit—I am just another runner shrouded by the anonymity of night. The men banter around me, urging me on. They shout "*¡Fuerte!*—Strong!" at Fernando. "*Pata de elefante*—elephant foot," they say, cracking jokes about my clumsy boots.

But the delicious sense of belonging cannot last. At dawn sunlight betrays me once more as an unreliable *chabochi*—a "bearded one," or outsider. When I collapse exhausted in the filigreed shade of a juniper, my boot toes chewed open by the stony racecourse, I am completely ignored.

How long do the Indians run? I wake up ten hours later, and they are still at it—a stubborn people moving across a vast and rumpled landscape. For another hour? A day? An eternity?

BEYOND GUACHOCHI, Chihuahua, once a sleepy clutch of adobes that served as Lumholtz's headquarters in 1893 but which today has exploded into a grubby Dodge City patrolled by police with M16s and packs of slat-ribbed mongrels, the route changes. The rivers of the Copper Canyon region foam 20 feet above their low-water marks, swollen with late summer rains. I point the mule east, skirting the maw of a mile-deep chasm called the Sinforosa, and ride into autumn—into Durango, a state that sprawls south under an older, yellower, more Mexican sun.

Logging roads flung like chalky strings

HUICHOL



Aloof as their mountains, a Huichol couple posed for Lumholtz in the remote uplands of Jalisco state. The explorer often faced a chasm of Indian mistrust. Among the Huichol, who carve their own fiddles, music offered a bridge: Lumholtz stunned villagers by bellowing out Huichol songs.

wilderness for too long, like a coin rubbed smooth by too many fingers. Ninety-eight percent of the cordillera's virgin timber, *never touched by a woodsman's axe,* is gone. So are the grizzlies and the Mexican gray wolves. So is the imperial woodpecker—once the largest in the world, two feet from crest to tail.

Still, away from the sierra's dog-eared mountain towns and dusty logging roads, the cordillera unravels through landscapes of great stillness and beauty. On the Río Mezquital in Nayarit, I wash the mule with hatfuls of water and swim naked under thousand-foot-high cliffs the color of sunburned skin. Overhead, a macaw scratches the soft winter sky again and again with its jagged call. A wild cry. It compresses the world into a sharp, clear point—then releases it, unclenching the heart with something like relief or wonder. It is here among the empty mesas and meandering ridges of the Durango-Nayarit border that I slowly come to accept that my quest is over.

True, I will spur the mule some 500 miles farther south, into the mountains of the Huichol, where Lumholtz spent ten lonely months unlocking the fantastic secrets of the peyote cult. And true, I will ride on through the short, golden afternoons of December before giving the mule to a kindly farmer in Michoacán. But I will never find Lumholtz. I simply stop looking. Just as I stop trying to reclaim my father's hands—an artist's hands, flecked with white paint: I used to believe there were clouds in his fingernails.

Still, if my own search fails, Lumholtz, as usual, proves a better seeker. Saddle-hardened and with Indian songs on his lips, he rides out of the Sierra Madre Occidental in 1898, a profoundly changed man, though one who never stops wandering.

In 1909 he will probe the desolate core of the Sonoran Desert on horseback and five years later paddle up tea-colored rivers in Borneo —adventures that spawn vivid, fact-jammed books of their own. But the pillars of Lumholtz's Victorian world, with its smug moral absolutes and granitic faith in the triumph of reason, have been shaken forever. The ancient people of Mexico have made Lumholtz uncertain of his place in the universe, which is to say they have made him modern.

Sharing their joys and sorrows, entering into their thoughts and learning to understand their lore and symbolism, I felt myself carried back thousands of years into the early stages of human history, the explorer concludes in *Unknown Mexico. Primitive people as they are they taught me a new philosophy of life, for their ignorance is nearer to truth than our prejudice.*

In 1922 when Lumholtz, afflicted with a fatal case of tuberculosis, is raising funds again in New York City (this time for a final expedition to New Guinea), Native Americans are held in such contempt they still are deemed unworthy of U.S. citizenship. Lumholtz's call for tolerance and understanding is mostly ignored, and so is he. Alone among strangers, he dies at an Adirondack sanatorium at Saranac Lake, unmourned by a world bored with the feats of gentlemen explorers. He is 71.

THE ANCIENT PEOPLE of Mexico have made Lumholtz uncertain of his place in the universe . . . they have made him modern.

I often wonder if, in the weeks leading up to that anonymous death, the distinguished old Norseman climbed the granite steps of the American Museum of Natural History. I imagine him frail but still fierce eyed. He stands in a dim storeroom among dozens of shaman rattles and hawk feathers, perhaps hefting a fire-blackened Tarahumara pot. And I wonder if he is haunted by the Sierra Madre as I am. "*No hay pierde,*" the campesinos say, giving directions, "there is no loss," meaning the trail, or the road, or memory.

Near the end of my journey, on the cobbled banks of the Río Grande de Santiago, the gurgling finish line of the Sierra Madre Occidental, I stop to build a small cairn of stones. I have offerings in my canvas saddlebags. A copy of a letter Lumholtz wrote while on the trail in the sierra in 1895. A small jade bird, a Mexican fetish that once belonged to my father. Things to leave behind, having crowded my heart with mountains.

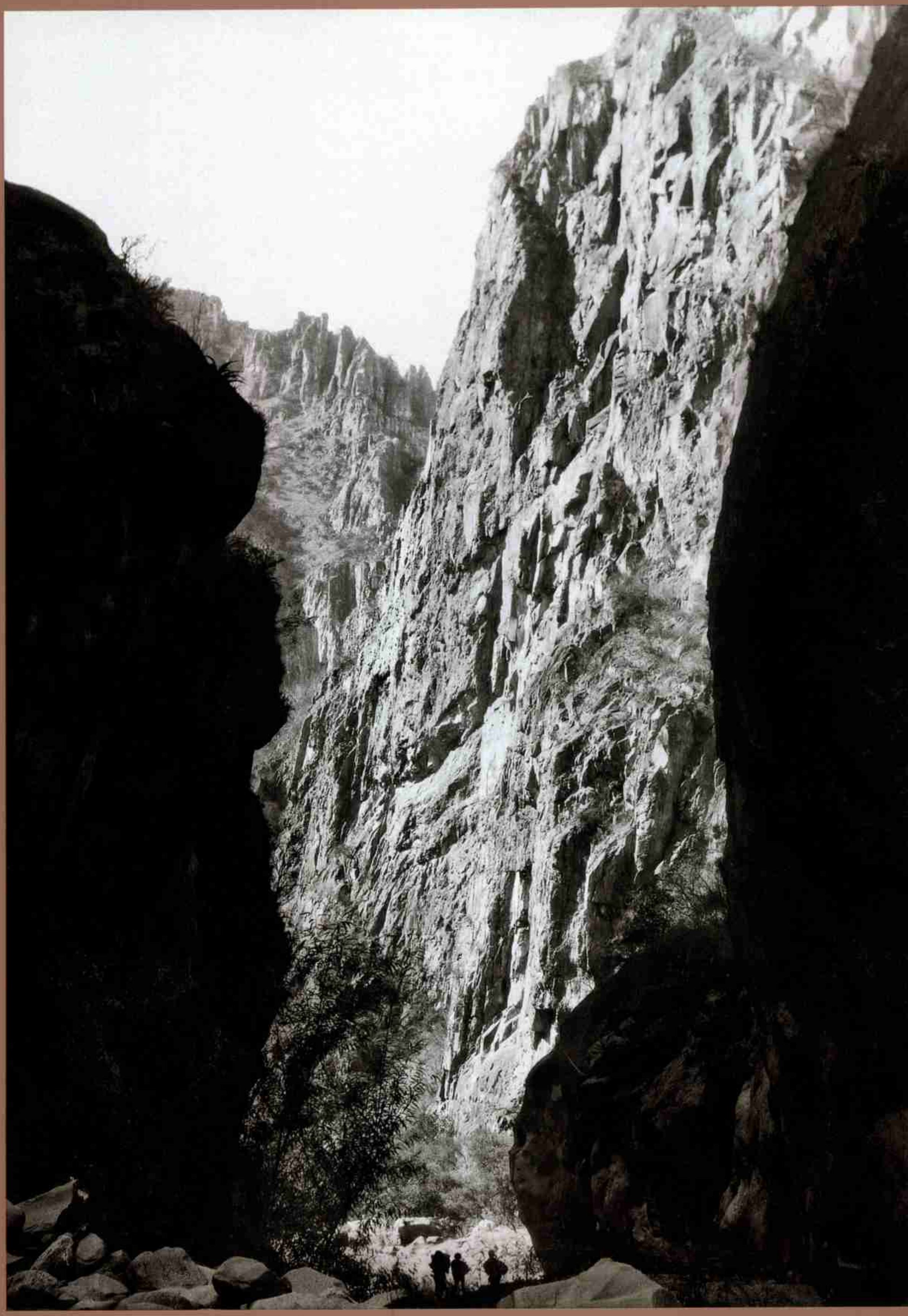
Halfway across the river I rein in the mule. Then I splash back to pick them up.



HUICHOL



Spiritual treasures on display, Huichol shamans stare solemnly over a thicket of sacred arrows, gods' chairs, and a statue of Grandfather Fire. During his travels Lumholtz delivered a Huichol plea for land protection to Mexico's president. Since then the group's lands have shrunk by half.



TARAHUMARA

"From where I stood . . . the country seemed forgotten, lonely, untouched by human hand," Lumholtz wrote of the gorges in Chihuahua that form the last redoubt of the Tarahumara. One canyon, the Sinforosa (left), plunges 6,000 feet. That shield of geography has kept the region's lifeways—and folk memories—intact. "I remember stories about the man on the mule," says an elder from the Indian village of Norogachi (below). "He came alone. He must have been crazy."



"Before the occupancy of the country by the new masters, the Tarahumares never knew what poverty was."

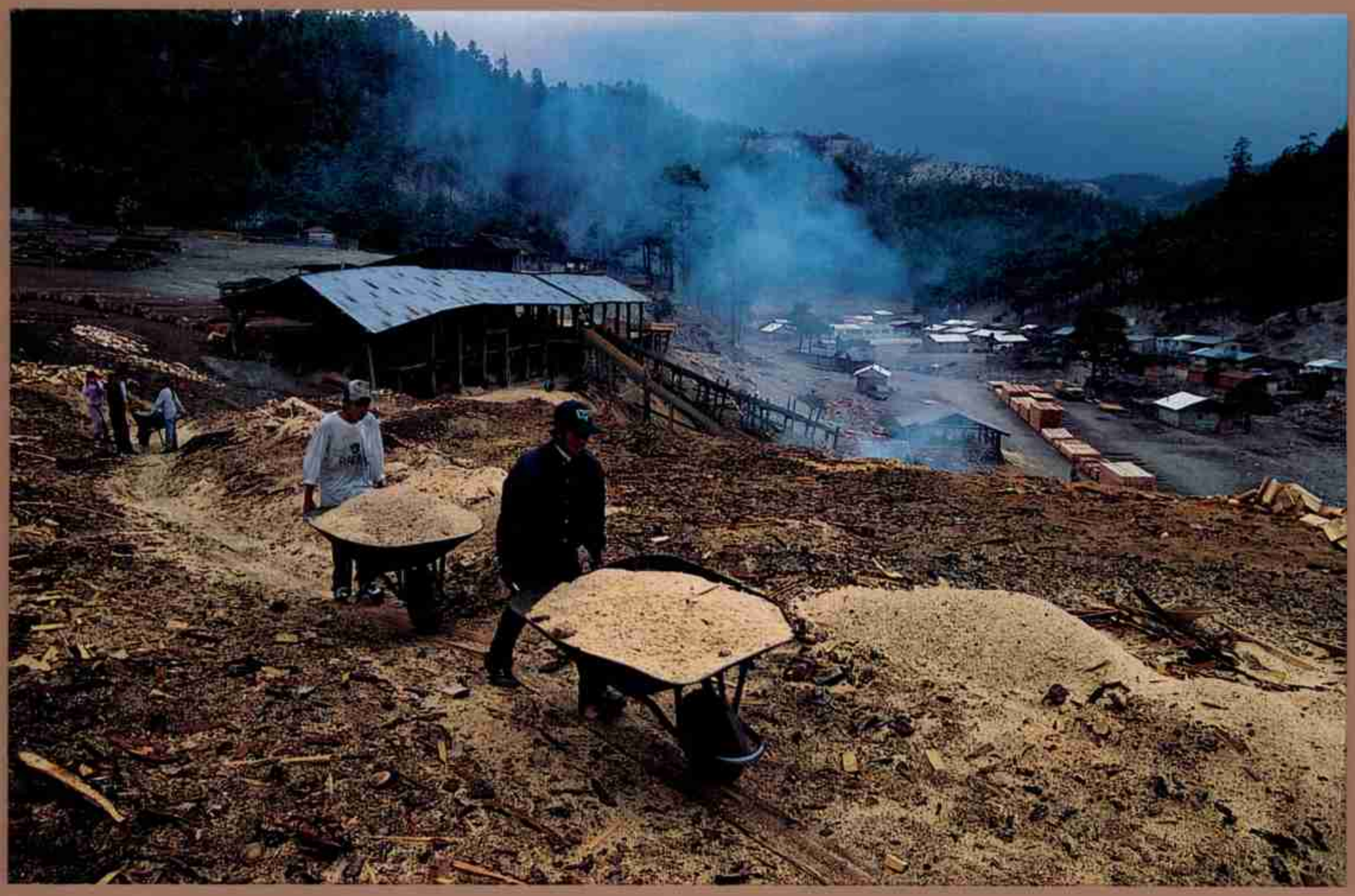
—CARL LUMHOLTZ



No Longer a World Apart

Troubling new treasures of the Sierra Madre, tourism and narcotics have sparked the latest invasion of outsiders to Mexico's fabled cordillera. Government planners are hoping that a bountiful cash crop of visitors (above) will soon supplant earnings from the sierra's drug fields, whose





opium poppies (below left) supply, by some estimates, a third of the heroin smuggled into the United States. Greed is an old and enduring curse in the sierra. Workers in Durango climb a mountain of sawdust (above), a monument to decades of overlogging. Huichol schoolchildren (below) will doubtless have to carry on an age-old battle: defending their lands from ranchers.







Pious actors, men of the Cora people take a break from dancing at religious festivals in Nayarit state. Lumholtz was deeply moved by the devoutness of the sierra's native peoples, who practice a hybrid faith mixing Roman Catholicism with the worship of the sun, lakes, and stars.



CORA

"Their lands once lost, the old religion is soon forgotten and with it their language, their traditions," Lumholtz fretted at the end of his five and a half years among Mexico's Indians. His pessimism was premature; the cultures of Mesoamerica live on in the prayer arrows and gods' eyes left in a sacred cave (left) and in the stories shared between a Cora elder and child (below). Today it is Lumholtz, the solitary adventurer and humanist, who has all but vanished into history. □



"Primitive people as they are they taught me a new philosophy of life, for their ignorance is nearer to truth than our prejudice."

—CARL LUMHOLTZ

Jelly

By RICHARD CONNIFF

Jellyfish pulse gently as they drift through a Pacific lagoon.

Feared by swimmers, loathed by fishermen, long unappreciated by biologists, and repellent to most who encounter them washed up on the beach, these gelatinous animals may be the ocean's most efficient and beautiful predators.



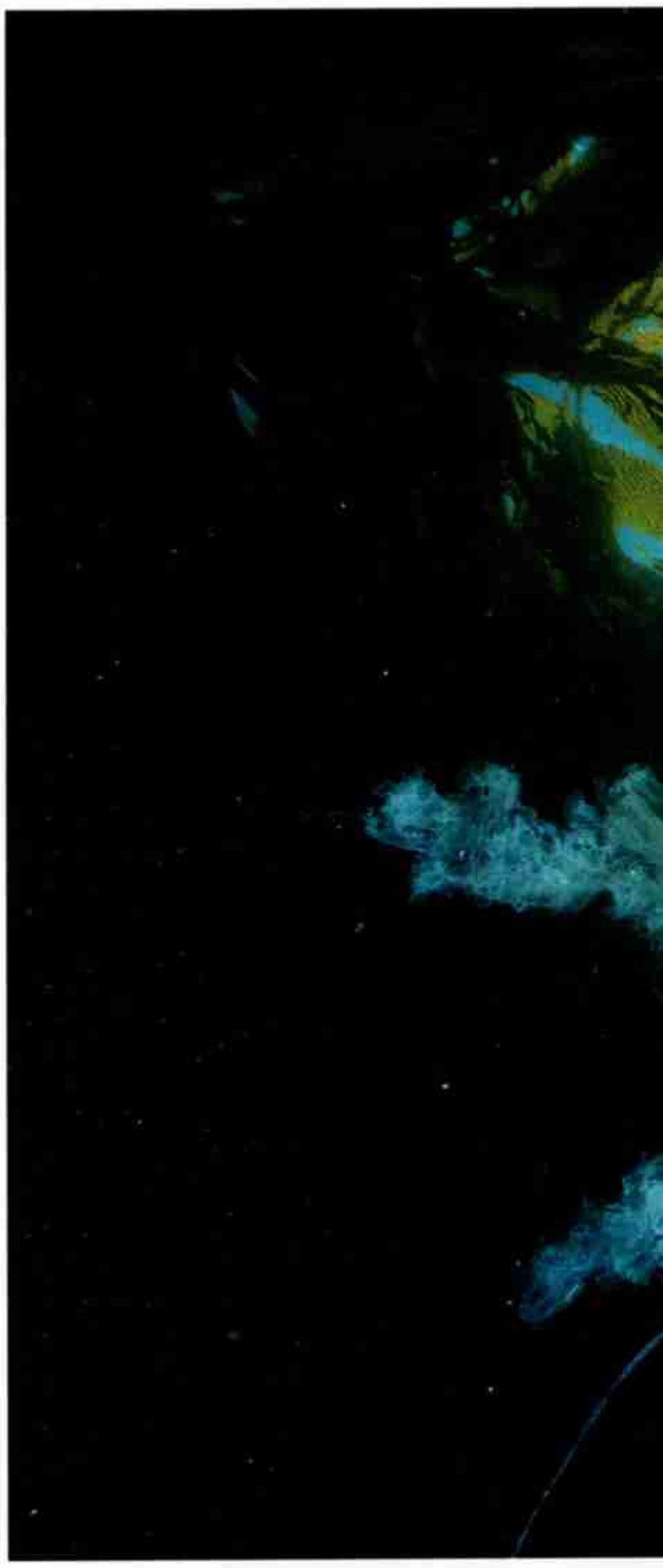
MASTIGIAS PAPUA,
UP TO 3 INCHES ACROSS, PALAU

Bellies

Photographs by DAVID DOUBILET

Look around and see all the jellyfish. You sayin' flotation is groovy, baby.

—JIMI HENDRIX, "POWER OF SOUL"



Look around at all the jellyfish—look at them, that is, in their own element, underwater—and the first thing that strikes you is their improbability, that something so beautiful could be made from such unpleasant stuff. It's as if a child with a bad cold had suddenly developed a gift for blowing Fabergé eggs through the nose. Jellyfish are one of nature's dreadful little miracles, repulsive and lovely at the same time: They weave a mucus-like gel into some of the most elegant forms on Earth.

They weave it into a way of life, and not the blobby, listless life we generally ascribe to creatures of the gelatinous persuasion. Until recently scientists knew jellyfish mainly from the dismembered goo dredged up in their nets, a kind of roadkill taxonomy. "It was like studying the rain forest by drifting over it in a balloon, flinging out a net, and seeing what you came up with," says Richard Harbison of Woods Hole Oceanographic Institution. "You might catch a hummingbird. You wouldn't know that it feeds on nectar." But over the past 30 years, by using scuba gear and submersibles, scientists have discovered that jellyfish in their own habitat are among the most numerous, effective, and, in some ways, ingenious predators on Earth. Without eyes (in most species), ears, or even a brain, jellyfish manage to affect almost everything that lives in the ocean.

One placid summer morning in Monterey Bay, on the central California coast, an unmanned submersible named *Ventana* rocked beside its mother ship, the *Point Lobos,* with nothing showing above the surface but a little plastic hot dog some joker had mounted on a radio beacon. The submersible slipped away from the ship off the starboard bow, trailing blue-white plumes from its thrusters. A thick yellow cable uncoiled in its wake, tethering it to the ship. "Clear to dive," someone said. A brief flurry of white geysers, and *Ventana* subsided with its plastic wiener into the depths.

Aboard the *Point Lobos* in the forepeak, a dark little room below the bridge, Bruce Robison of the Monterey Bay Aquarium Research Institute (MBARI) sat at a bank of video monitors, studying the images sent up by the submersible. They were stranger than any transmission from outer space. Constellations of jellies drifted in out of the darkness, looming brighter and larger as *Ventana*'s camera drew close. One jelly looked like a cocktail onion, one like a rocket, one like a Rastafarian from Alpha Centauri.

RICHARD CONNIFF often writes about animals people love to hate. He is the author, most recently, of *Every Creeping Thing: True Tales of Faintly Repulsive Wildlife.* A collection of more than 25 years of DAVID DOUBILET's work, *Water Light Time,* was published last year by Phaidon.



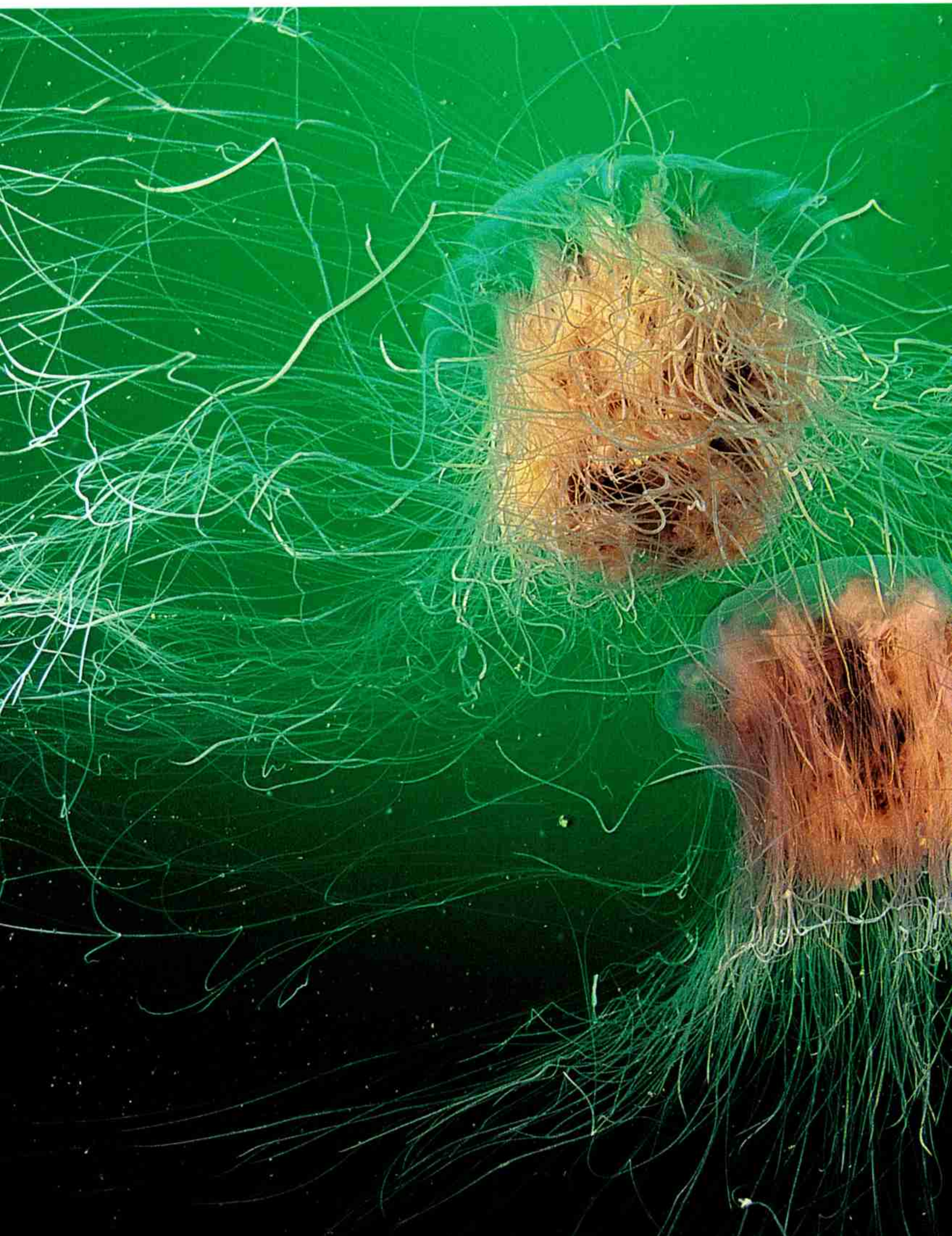
PHACELLOPHORA CAMTSCHATICA, UP TO 24 IN ACROSS

These jellies were actually doing stuff, not just drifting. One comb jelly, a sort of flying wing up to two feet long, behaved like a crop duster working a cornfield. On its trailing edge it had a comblike row of paddles, called cilia, for propelling itself through the water. These cilia produce almost no bow wave, so comb jellies can sneak up on their prey. Scientists call it "stealth swimming." But this particular species produces plenty of turbulence to the rear, so it feeds by cruising one way for a few yards, then climbing up three inches and methodically reversing course to capture tiny crustaceans fleeing the wake from its first pass. I got the impression that jellies are not necessarily helpless.

ADRIFT: A fried-egg jelly floats too close to shore in Monterey Bay, where it will be battered by waves and kelp. Living at the mercy of the currents can be risky, but it has advantages. Jellies move with their planktonic food without wasting much energy swimming.

"Here's *Colobonema*," said Robison, as the submersible descended. The pilot, working a joystick, moved the 6,500-pound *Ventana* toward the animal in question and then felt the submersible strain against its tether. "Gimme some slack," he called up to the bridge. "I'm like a dog trying to get to a fire hydrant."

"*Colobonema* is the one that drops its tentacles when it's pursued," Robison said.



CYANEA CAPILLATA, UP TO 7 FEET ACROSS, NEW JERSEY



"BEHOLD THE LION'S MANE!" cried Sherlock Holmes, fingering the murderer in an Arthur Conan Doyle story. The "waving, vibrating, hairy creature . . . can be as dangerous to life as, and far more painful than, the bite of the cobra." It's a bad rap. The sting of a lion's mane jelly hurts but almost never kills—unless you're a copepod.



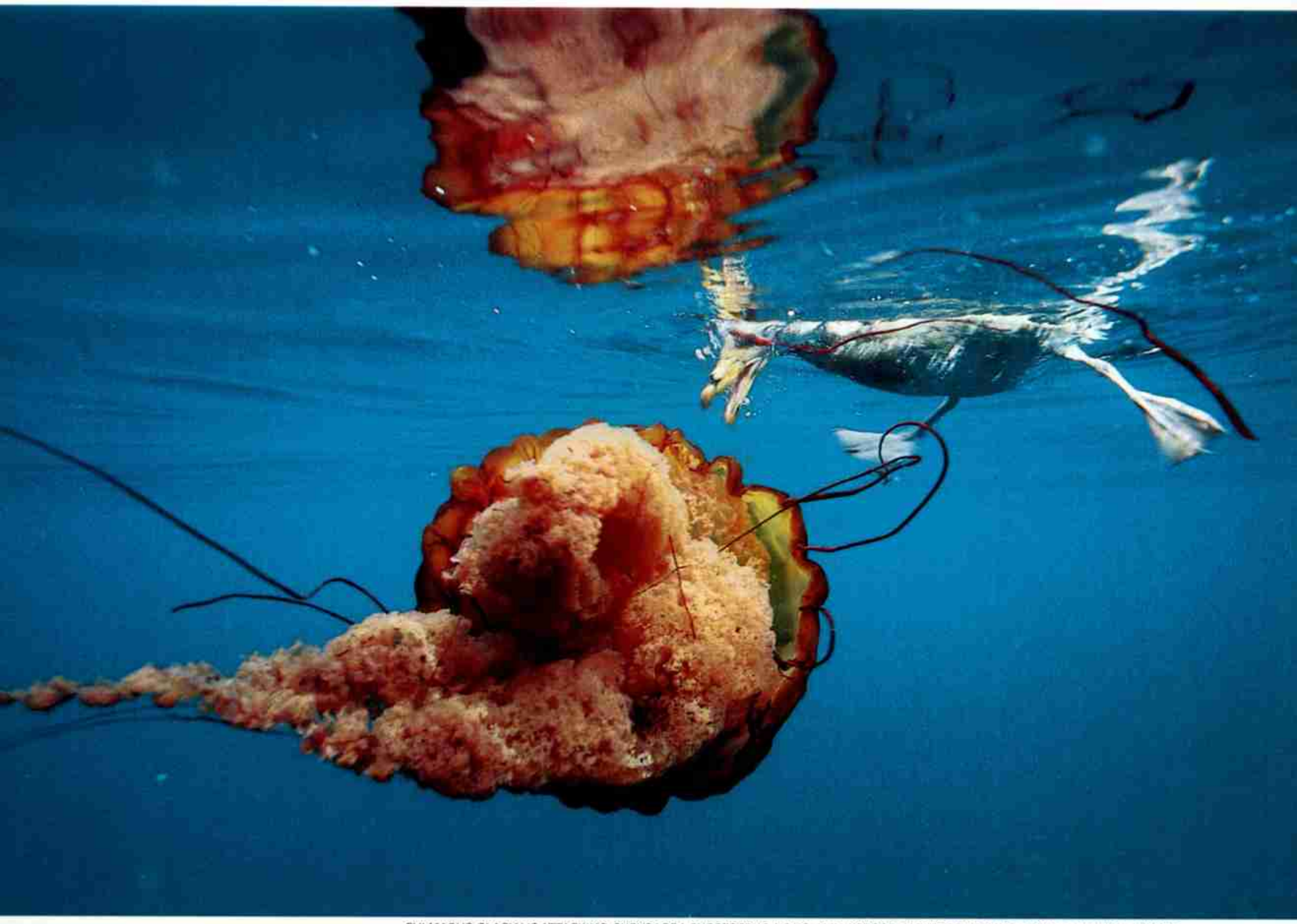
URTICINOPSIS ANTARCTICA FEEDING ON *DESMONEMA* SP., UP TO 20 IN ACROSS, McMURDO SOUND, ANTARCTICA, NORBERT WU

"Sometimes you just look at it funny. But usually it takes a disturbance." Dropping tentacles is a distraction technique, like the way a lizard sheds its tail in the heat of a chase, so its pursuer will lunge for the wriggling appendage and let the lizard escape. But jellyfish do it better.

Ventana took up the chase, its thrusters roaring, its lights blindingly bright. Sensing a threat, the jellyfish merely pulsed out of reach. *Ventana* made two more passes without ruffling the *Colobonema*'s jelly belly cool. "You gotta give this guy points," the pilot said. "He's holding it together. I can't hassle him any more." But then the pilot's eyes gleamed as another *Colobonema* loomed up in his sights. The jellyfish darted away—and this time left behind a bright shower of shed tentacles riddled with stingers. Escape and vengeance in a single sticky package. Robison believes the tentacles are bioluminescent. A would-be predator lunges for them in the depths of the ocean, allowing the *Colobonema* to escape. As a last-ditch effort some species of jellyfish actually use bioluminescent displays to light up a predator and make it a target for everybody else. "Nature's wonders," said Robison, eyebrows raised. "Now let's get outta here." And *Ventana* sank another 300 feet into the abyss.

A LEAN, NASTY MEAL for most predators thanks to toxins and watery tissue, jellyfish still sometimes end up eaten by sea anemones (above) or pecked by birds. A few animals—leatherback turtles and ocean sunfish among them—digest a steady diet of jellies.

Robison, grizzled and garrulous, is an old-style net-dragging fish scientist who was born again at mid-career into the world of jellyfish. It happened because a bird biologist named Bill Hamner had become allergic to feathers. Hamner was considering a switch to oceanography and went along with Robison on a 1969 collecting trip.



FULMARUS GLACIALIS ATTACKING *CHRYSAORA FUSCESCENS*, UP TO 12 IN ACROSS, MONTEREY BAY, CALIFORNIA, DAVID J. WROBEL

"He kept looking at the stuff we dragged up in a net, and it looked terrible. So he said, 'Why don't we just go down and look at it.' A birder's mentality." Robison cringed at the thought. "I said, 'You can't do that. Nobody's ever done it before. This is how we do marine science. We tow nets.'" But Hamner persisted.

"We started diving down there," said Robison, "and it wasn't anything like we thought it was going to be. The principal difference was the gelatinous stuff. The jellyfish were so much more abundant and so much more important ecologically than the nets ever told us."

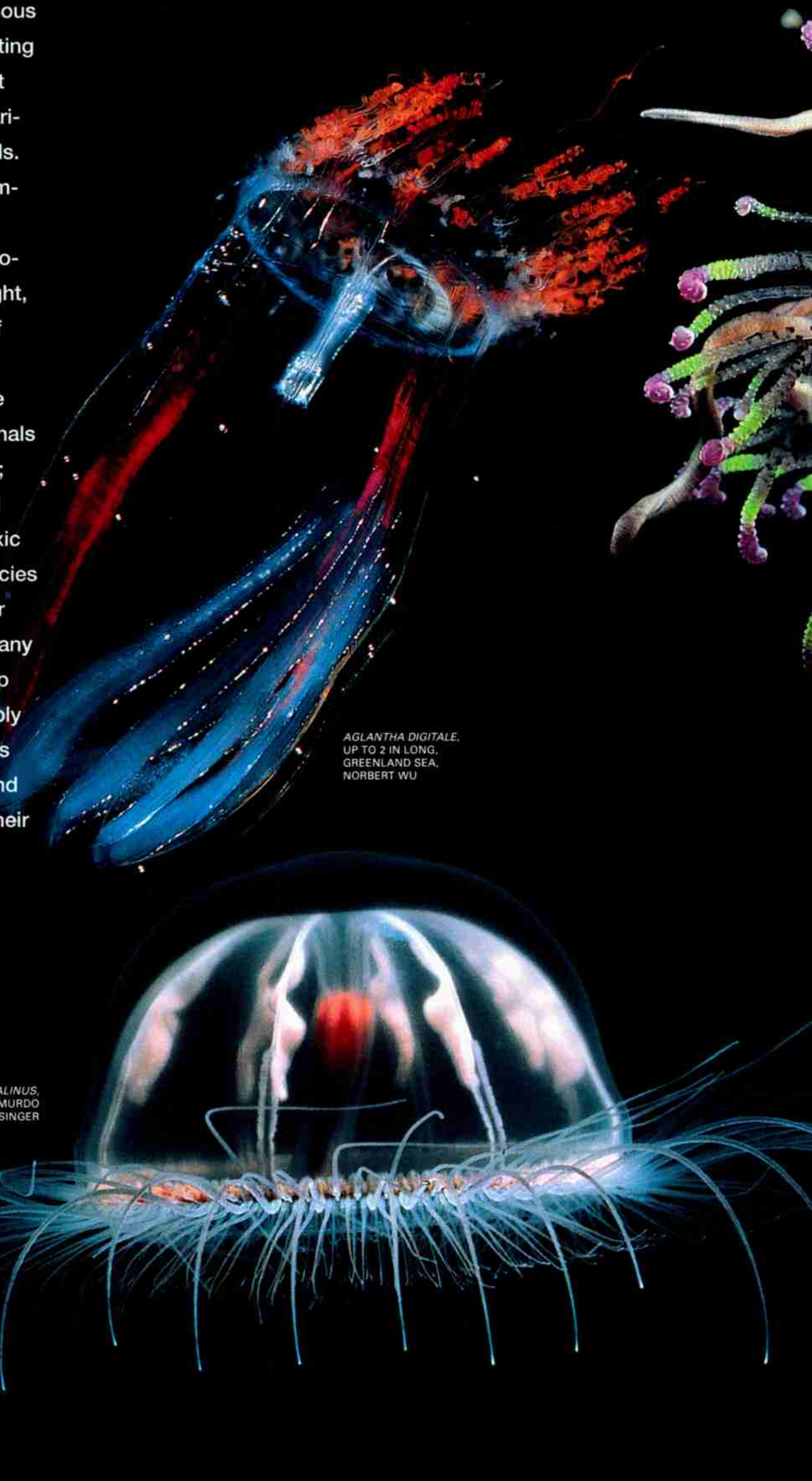
Hamner, now at UCLA, went on to introduce an entire generation of other scientists to the joys of underwater gelatinology. He is now widely regarded as the intellectual godfather of those who swim with the jellyfish. In the early 1990s Hamner also made it more appealing to put jellyfish on display, by modifying an aquarium tank called the kreisel, which uses circular currents to keep the jellies floating in mid-water. Until then, the average layperson's response to jellyfish had consisted of the single word "yuck" (and a liberal salting of meat tenderizer for soothing nasty stings). But the hypnotic, even hallucinatory, beauty of these creatures was a revelation. People now buy jellyfish Beanie Babies, keep jellyfish as pets, and, in one fashionable San Francisco restaurant, sip their drinks under jellyfish chandeliers. After roughly 600 million years of unglamorous obscurity, jellyfish are suddenly cool.

A few clarifications are therefore in order: They aren't fish, and they aren't jelly either. Unfortunately, no better name has suggested itself. One scientist refers to them affectionately as "sea boogers," but this surely will not do.

The creatures we call jellyfish do not fit into any neat biological category the way, for instance, lobsters, shrimps, and crabs are all classified as crustaceans. Scientists

Kings of Squish

Thousands of gelatinous species live free-floating in the seas. The most diverse are the cnidarians, relatives of corals. Their body plan is simple: a bowl-shaped, contractile bell for propulsion (*Aglantha*, right, ascends hundreds of feet each day to find plankton); a digestive cavity; spoke-like canals for nutrient transport; and tentacles loaded with cells that fire toxic harpoons. Some species have tentacles longer than a blue whale. Many jellies that seem to tip and yaw uncontrollably can orient themselves with the help of tilt and light sensors along their bell margins.



AGLANTHA DIGITALE, UP TO 2 IN LONG, GREENLAND SEA, NORBERT WU

BENTHOCODON HYALINUS, UP TO 2 IN ACROSS, McMURDO SOUND, BILL CURTSINGER

OLINDIAS FORMOSA, UP TO 3 IN ACROSS, IZU OCEANIC PARK, JAPAN, ANNE L. DOUBILET

AEQUOREA SP., UP TO 7 IN ACROSS, TASMAN SEA, AUSTRALIA

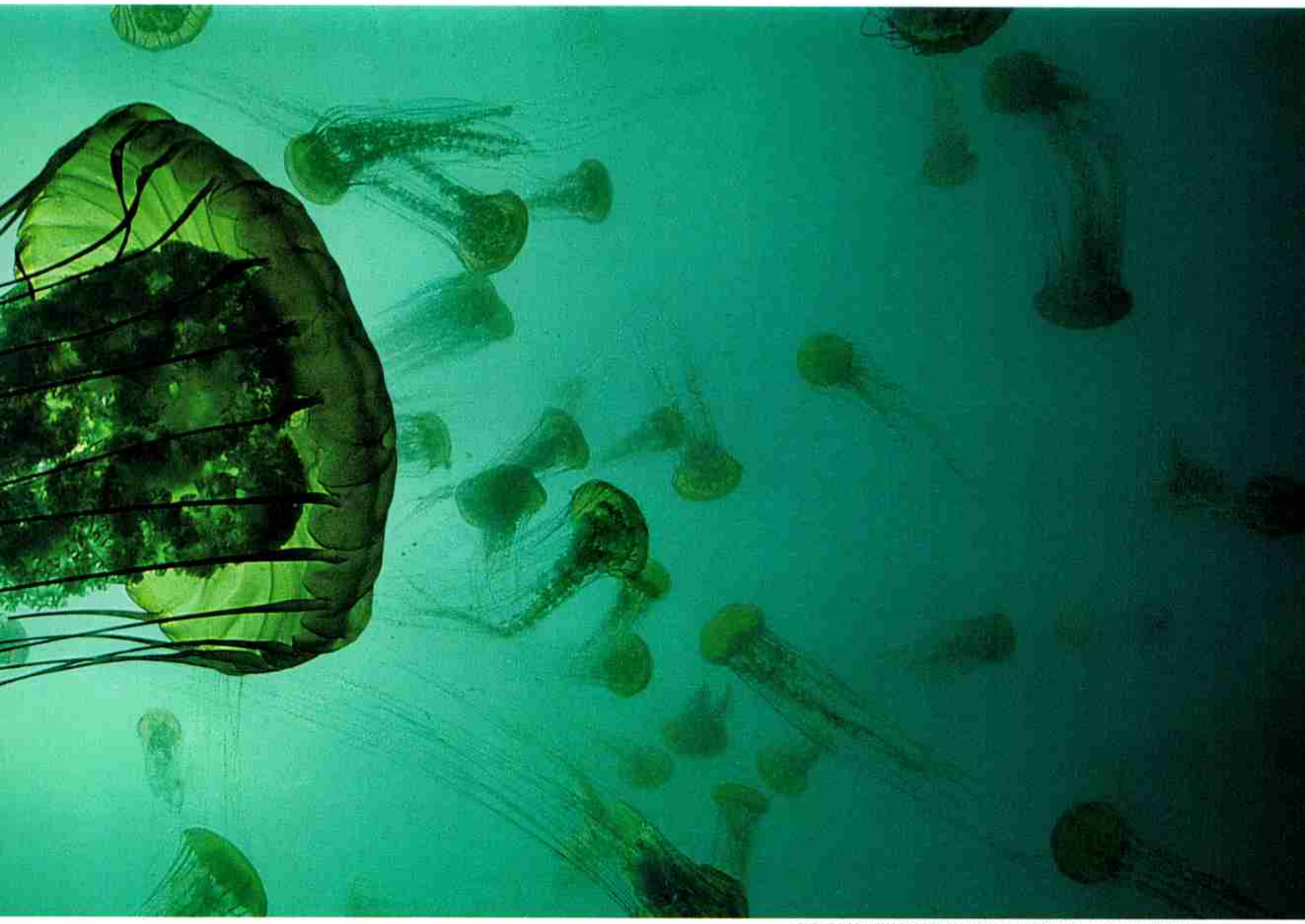
PERIPHYLLA PERIPHYLLA, UP TO 8 IN LONG, McMURDO SOUND, BILL CURTSINGER



divide the entire animal kingdom into roughly 30 groups, called phyla, and gelatinous creatures turn up in at least five of them. (By contrast, all vertebrates on land and in water, including cats, bats, birds, snakes, dolphins, and humans, make up only part of one phylum, the chordates.) Most so-called jellyfish are either ctenophores (comb jellies) or cnidarians, which typically have the conventional bell-like shape and stinging tentacles. But some worms, snails, and squid also pass for jellyfish, as do several of our kin among the chordates. An appendicularian may not look like our distant cousin. It looks, in truth, like a tiny, fluttering strip of transparent ribbon candy. But it has a nerve cord like us.

Why have so many creatures evolved the gelatinous form? Because it's what works in the ocean. The building material is cheap and readily available: a few proteins together with a lot of polysaccharides—long sugar chains that soak up water—producing an animal that's 95 percent liquid. So a gelatinous animal can rapidly increase in size when food is plentiful, and it can spew out huge blooms of new individuals. When food becomes scarce, a jelly can shrink down again and travel light. Being, in essence, organized seawater means a jelly can manipulate its buoyancy for migrating up and down in the water column. A sturdier body isn't necessary in the ocean because there's hardly anything to run into and gravitational force is less of a factor. A more solid body would also be harder to conceal. In a world with few hiding places, being transparent is a jelly's best defense.

SEA NETTLE SOUP: After a two-year absence, jellies filled Monterey Bay last summer. Less than 5 percent organic matter, jellies can quickly convert food into mass. When there is plenty of prey, they regenerate damaged parts and grow in size and number.

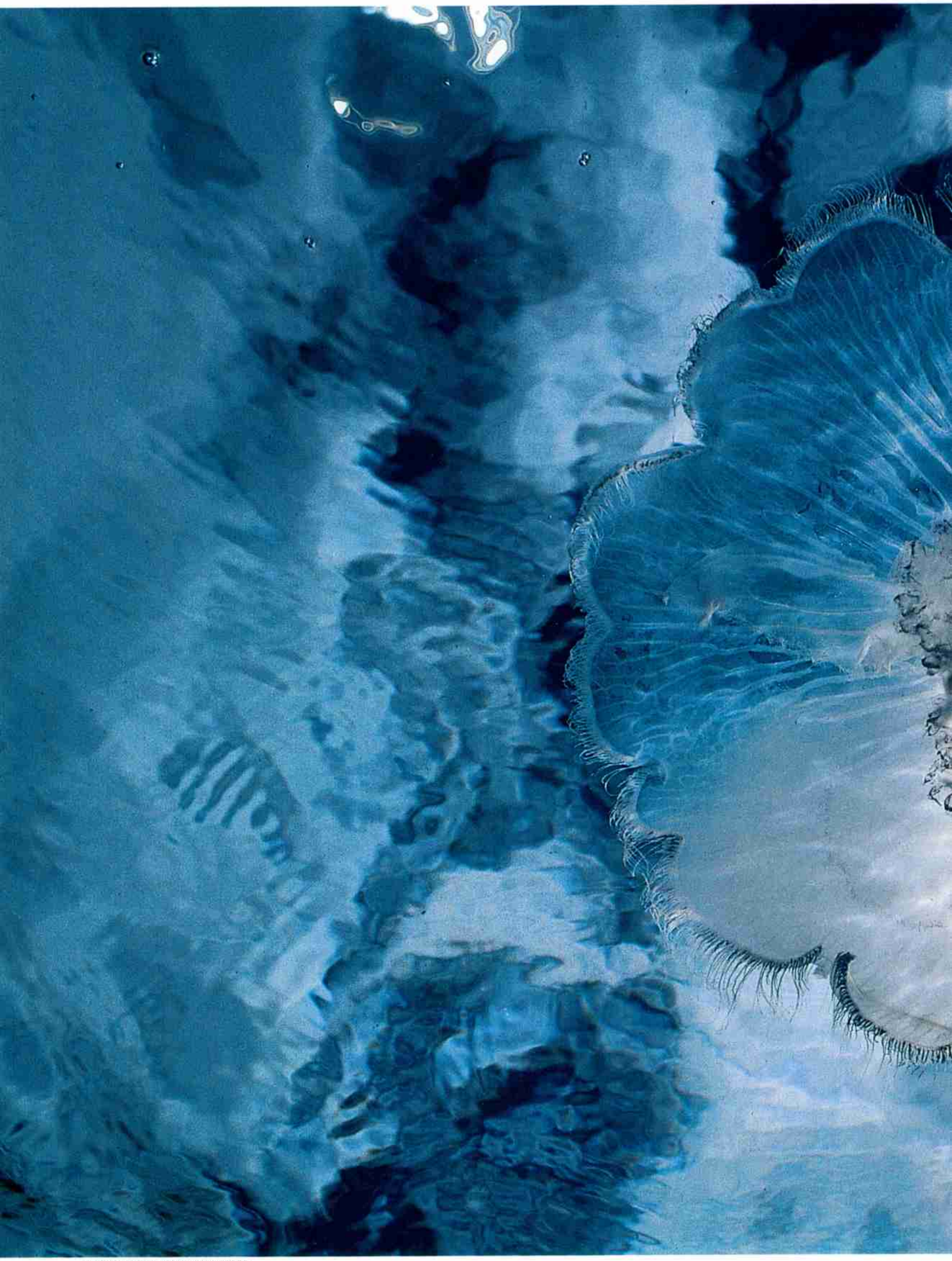


CHRYSAORA FUSCESCENS, UP TO 12 IN ACROSS, DAVID J. WROBEL

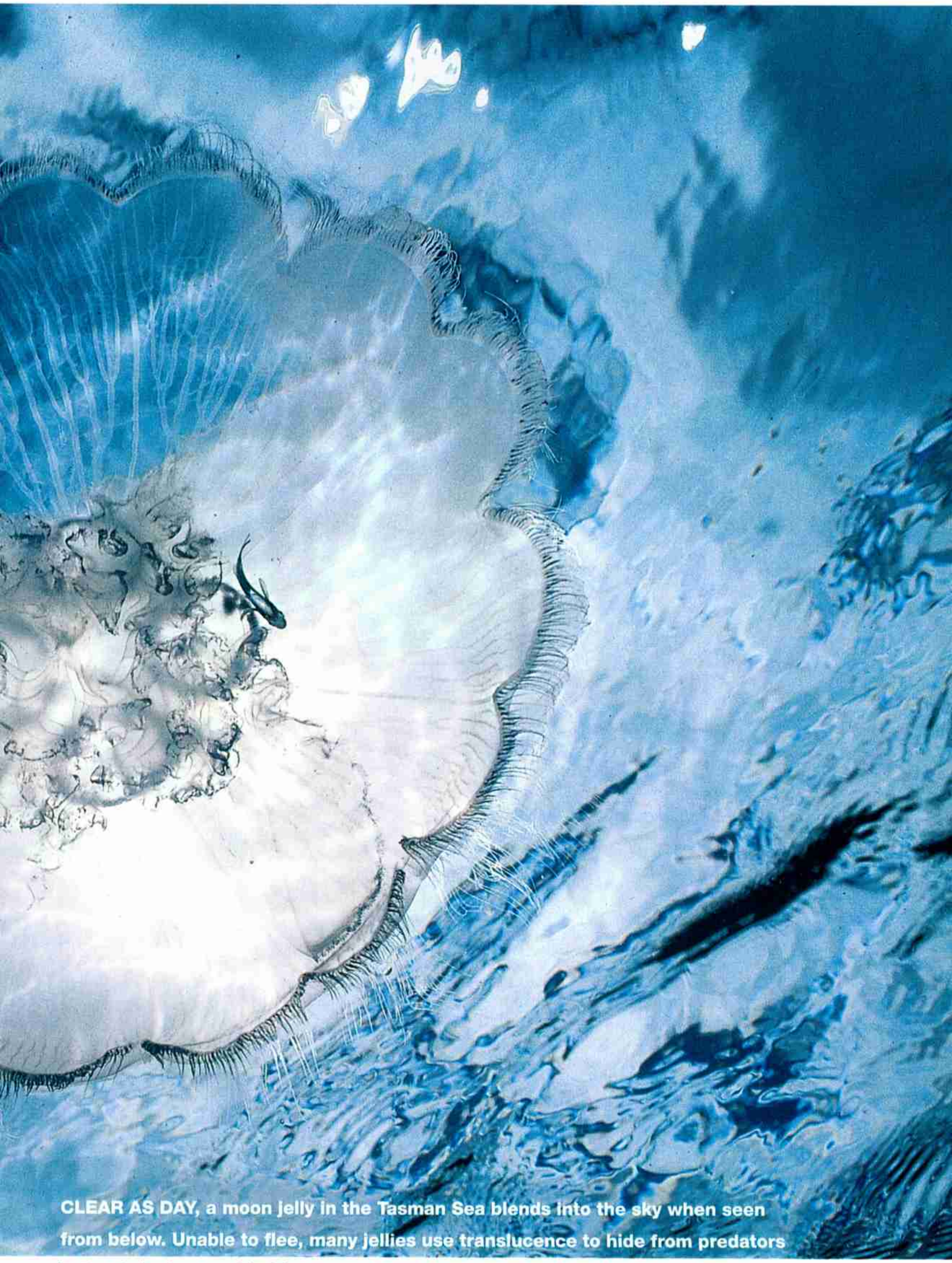
But the gelatinous lifestyle isn't necessarily diaphanous or flimsy. Consider, for example, a problem in jellyfish engineering: Muscles can only contract; they can't stretch themselves out. The human solution is to use opposing muscles anchored to bone to bend and unbend our limbs. But jellyfish are far too simple for that. They can contract their bodies to shoot out a jet of water, but they have no opposing muscles to yank themselves back into shape. So some jellyfish are built around a transparent disk called the mesoglea. It's like mucus but with collagen fibers mixed in to make it tough and rubbery. It has shape memory, like the padded-shoulder insert in a woman's jacket. When the jellyfish contracts its muscles, the mesoglea bends with it—and then springs the entire jellyfish back to its original shape.

With slime as your basic building material, you can apparently do almost anything. For example, an appendicularian uses mucus to construct an elaborate house, a mesh structure ranging from the size of a pea to the size of a doghouse. Suspended within this home, it merely flutters its tail to drive water through a pair of tubular circulators and into two screens, also made of mucus, which filter out minute food particles. If the house or the screens get clogged, the appendicularian simply moves out and builds a new place. A comb jelly, in turn, has evolved to feed on appendicularians. It opens up like an umbrella and engulfs the appendicularian, house and all. Then it waits patiently until the appendicularian, fluttering within, realizes it's not getting any food. "The appendicularian reacts as if its screens are clogged," says Richard Harbison of Woods Hole, who recently observed the behavior for the first time in the Antarctic. It leaves the house—and swims straight into the comb jelly's mouth.

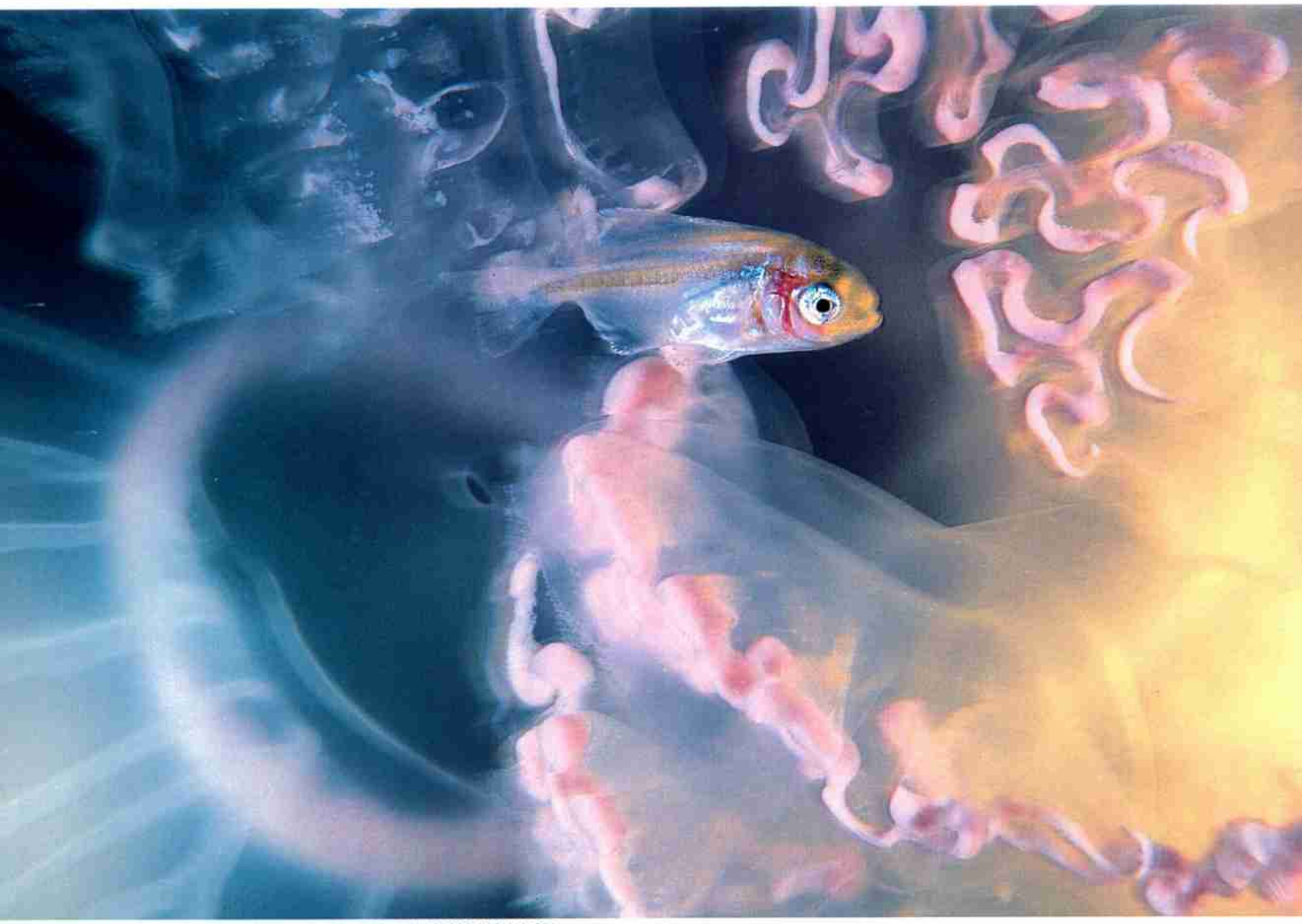
Reading about jellyfish, I started to make a list called "Fifty Clever Things to Do With Mucus." Many of the cleverest tricks have to do with killing.



AURELIA AURITA, UP TO 12 IN ACROSS



CLEAR AS DAY, a moon jelly in the Tasman Sea blends into the sky when seen from below. Unable to flee, many jellies use translucence to hide from predators in the shelterless world of the ocean. Moon jellies use mucus on top of their bells as well as short tentacles to capture prey. The fish below this jelly is a temporary visitor.



SERIOLELLA BRAMA IN *AURELIA AURITA*, UP TO 12 IN ACROSS, TASMAN SEA

Another jelly, a chain of linked individuals called a siphonophore, makes tiny fishing lures with its own flesh. They look deceptively like larval fish or small crustaceans. The siphonophore dangles these lures at the end of long tentacles, jigging them through the water with a convincing twitch. Fish that fall for them get a mouthful of deadly stingers, and their carcasses are slowly hoisted up into the jellyfish. In one case a single siphonophore was fishing 85 lures at a time, like a party boat out for bluefish.

On the video monitor *Ventana* was showing us a commonplace siphonophore named *Nanomia,* a frilly little thing six inches long. "By our estimate," said Robison, "that one species takes a quarter of all the krill in Monterey Bay. They're probably the dominant predator of krill here, duking it out directly with blue whales and salmon." Another siphonophore named *Praya,* which is arguably the longest animal on Earth, lurked somewhere deep below us. MBARI researchers once announced that they had measured a *Praya* longer than a blue whale (though only about as thick as your wrist), causing anxious parents to phone in about whether they should let the kids swim with a 130-foot predator. MBARI gently advised them that their children would be in danger only if they happened to swim 800 feet deep, where *Praya* lives, and even then it would help if they resembled small crustaceans. But I had the feeling that the scientists were secretly thrilled to see jellyfish getting even this misguided respect.

DRIFTING SAFE HOUSES, jellyfish offer refuge to small fish, which hover nearby, then dash among tentacles when danger appears, somehow avoiding being stung. Crabs eat bits of food captured by their hosts—supplemented with bites of jelly flesh.



CANCER GRACILIS IN *PELAGIA COLORATA*, UP TO 28 IN ACROSS, MONTEREY BAY

JENNY PURCELL, who wears a cap embroidered with a sea nettle rampant, is a leading proponent of the idea that jellyfish are among the great predators on Earth. Out on the Chesapeake Bay in Maryland one summer morning, she was raking her fingers through tray after tray of slime, sorting out the pearly little globs called *Nemopsis*, a cnidarian, from the thick mass of *Mnemiopsis*, a comb jelly. (Comb jellies have no sting, Purcell explained, and other jellies with stingers geared to small, soft prey may not be potent enough to penetrate human skin.) Now and then a sea nettle turned up or a fragmented moon jelly, which she pieced back together like a jellyfish jigsaw puzzle, just to make sure it was one individual and not a crowd. The idea was to survey this neck of the bay, using plankton nets and scuba gear, to see which jellyfish were at home and how they might be affecting the food chain.

People tend to regard jellyfish as a problem for two obvious reasons: We don't like getting stung, and we don't much care for getting slimed either. In the Chesapeake, sea nettles are sometimes so thick it seems as if you could walk across them; they have such a fiery sting that most people simply do not swim in the heat of summer. Blooms of jellyfish also seem to have become more common around the world. Last year on the French Riviera big magenta-colored *Pelagia* jellyfish turned up in such dense clumps that they shredded 5,000-pound fishing nets. In Japan jellyfish have clogged seawater intake pipes and forced a nuclear power plant to throttle down. But Purcell and other researchers have begun to think that jellyfish affect habitats—and humans—in ways that are much subtler than that, and also far more profound.

"They're always there, and always eating," said Purcell, who teaches at the University of Maryland Center for Environmental Science. She once studied a bay in British

Columbia where the dense, swirling schools of herring turn the water milk white with their spawn. But one year a bloom of crystal jellies wiped out the entire crop of larval herring. "And even when they're not decimating the fish directly," she said, "they're chowing down on food that would otherwise go to fish."

Purcell is a low-budget researcher. (All jellyfish research is low-budget, relatively speaking: The U.S. government spends roughly 14 billion dollars a year studying outer space but just 160 million dollars getting to know all the alien life-forms in our own oceans.) Her idea of a submersible is a video camera mounted on a rack of PVC tubing, with a two-dollar model airplane propeller from the hobby store to indicate the speed of the current. But she is painstaking and meticulous. One of her techniques is to strap on scuba gear, capture a jellyfish in a plastic jar, and immediately inject preservative into the jar at the jelly's natural depth, so she can measure its last undigested meal down to the slightest morsel. In one case she calculated that a single sea nettle as big around as a saucer was eating up to 18,682 copepods a day. Copepods are tiny flealike crustaceans and happen to be among the most numerous animals on Earth. Not even their mothers would miss 18,682 of them. But if they weren't being glommed by booming jellyfish populations, the copepods might be food for the kind of fish we eat. Purcell figures that in the Chesapeake Bay, sea nettles and comb jellies together may also consume up to half the daily production of bay anchovies, an important food for game fish and aquatic birds.

The world probably does not need new reasons to loathe jellyfish. So another clarification is in order: Jellyfish misbehavior may be at least partly our fault. No one knows for sure, but jellyfish blooms may occur in part because we overload a body of water with fertilizers and sewage. This leads to an increase in the planktonic plants and animals on which jellyfish feed and creates a low-oxygen environment in which fish die but jellies thrive. Jellies may also benefit when we knock out their major rivals through overfishing. Some scientists estimate that bringing back oyster populations to their old levels in the Chesapeake would reduce the jellyfish population by 90 percent.

But even now scientists have only the most rudimentary understanding of the relationship between jellies and other marine species, and our ignorance may have unfathomable consequences. In the Gulf of Maine, for example, copepods are the primary food for larval cod and other fish. But the cod have gone bust, and Marsh Youngbluth of Harbor Branch Oceanographic Institution worries that gelatinous creatures may be elbowing ahead of them at the copepod smorgasbord. Cod eat only what they can see. But jellyfish are nonvisual predators. They simply wait, everywhere, with dangling toxic tentacles like "a curtain of death" for the copepods. "People think, We'll just stop fishing and the cod will come back," says Youngbluth. "Well, it doesn't always work that way." It can be a matter of who fills a niche first or more effectively. In the 1980s the Black Sea fishery was suffering from pollution and overfishing. Then some ship flushed its ballast water and accidentally introduced the comb jelly *Mnemiopsis*, which blossomed in its new home. The human catch of anchovies subsequently plunged from 600,000 to 200,000 metric tons a year, and it has yet to recover.

BATTLE WORN, a purple-striped jellyfish has only stumpy tentacles left protruding between the rim of its bell and its nonstinging oral arms, which carry food from tentacles to mouth. Most adults live a few months; this one may be more than a year old.

But if jellyfish are always out there and always eating, then surely someone is eating them too? At Woods Hole, Richard Harbison is still adding to his list of several hundred species known to practice what he calls "gelatinivory" (rhymes with quivery). The list includes powerful game fish like tuna, utterly ungelatinous 1,200-pound leatherback turtles, ocean sunfish the size of Volkswagens, and such oceanic birds as



PELAGIA COLORATA, UP TO 28 IN ACROSS, MONTEREY BAY

fulmars and phalaropes. Gelatinivory, says Harbison, may be as important an adaptation for marine animals as is eating plants. Jellies appear to be the major food source for chum salmon and butterfish, for example, and Harbison believes their dietary importance to other species like red snapper may be underestimated because the evidence gets digested so quickly.

"Jellyfish are very easy to eat," says Harbison. "They don't swim very fast. But they're mainly water. So one of the major things a predator has to figure out is how to get rid of the water." Sunfish, leatherbacks, and some other species have evolved pharyngeal "teeth" at the backs of their throats. Having swallowed a jellyfish, they regurgitate it against these teeth to strain out the water and save the edible tissue. When sea turtles mistake balloons and other plastic objects for jellyfish, this process of regurgitation may actually suffocate them. In addition, certain fish such as those in the genus *Peprilus* have evolved pharyngeal sacs, like a chicken's gizzard, lined with barbed teeth for grinding up jellies; Harbison theorizes that they may also use an enzyme to separate the edible tissue from water. "A fish will eat a lot of jellies, and you can see its stomach bulge out," he says. "Then it starts making these gulping motions with its mouth, and the belly will start to go down, and then it will eat jellies again. So what I think it's doing is expelling water." Jellyfish themselves are among the most voracious predators of other jellyfish. Sometimes you can see one wrapped up inside another, neat as a piece of fish shrink-wrapped at the local supermarket. Look closely and you may even see the victim's victim, a krill or copepod it was eating when its final meal was so rudely interrupted.



THE GREAT WHITE SHARK of the jellyfish world is a comb jelly of the genus *Beroe*, and one day I went out in search of *Beroe* with Dave Wrobel, a jellyfish keeper at the Monterey Bay Aquarium. It was a blustery, overcast day, with the waves rolling in and fog intermittently obscuring the rocky shore of Point Piños. Wrobel cut the engine on the Boston Whaler in the middle of a long slick formed by a meeting of winds and currents. Strands of drift kelp twined in the dark green water, and we began to see jellies all around us. Wrobel and a docent named Leon began to scoop up sea angels, a gelatinous snail with small, fluttery wings and a long diaphanous mermaid bottom. Bits of siphonophores drifted past and the tough, rubbery carcass of a salp, a gelatinous chordate, studded with tubercles. I scooped up a *Beroe*, and in my hand it was shapeless, quivering like a soft candy lozenge. But when I put it in our water-filled collecting bucket, it spread out again, becoming delicate and conical, its comb-plate fringes shimmering in the light. The wind started to kick up, and we headed back to the aquarium.

I hung around to watch *Beroe* in action because I had heard that they are unlike any predator on land. A *Beroe* can engulf a victim twice its size in a single bite. Then it seals itself shut like a Ziploc bag and does a sort of hula shimmy until the excess water comes leaking out its mouth. "Mucus," one researcher had told me, "is a wonderful material." The modified cilia of the mouth also serve as teeth, making *Beroe* the only jellyfish capable of delivering a bite. I watched a *Beroe* for a while taking



CASSIOPEA XAMACHANA, UP TO 6 IN ACROSS

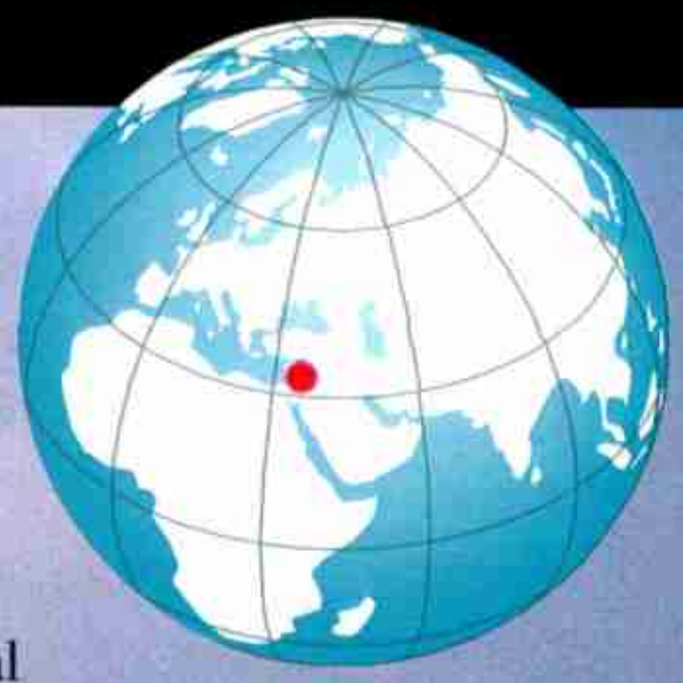
chunks out of another jelly, and it was like a Christmas ornament making war on a Victorian lampshade.

But then I got distracted by a nearby tank, where a sea gooseberry, named for its size and spherical shape, was bumping busily back and forth powered by its comb plates. Fine Rapunzel-hair tentacles streamed behind it, catching bits of food from the passing currents. After a while the sea gooseberry stopped, as if to contemplate its quandary: Say you have no arms, and you've struck on this system of collecting food with the hair on the back of your head. Now how do you get the stuff around to your mouth? The jelly began to spin like a top, till its hairlike tentacles wrapped all the way around it. Then, languidly, it drew the tentacles one by one back through its mouth, slurping off the morsels of food. Another jellyfish caught my eye, and then another, and it was all stranger, lovelier, even groovier than anything Jimi Hendrix might have imagined in his most visionary moments. I lingered blissfully among the jellyfish, and the word "blob" never once crossed my mind. □

THE UPSIDE-DOWN jellyfish spends most of its life with bell on the seafloor and algae-filled oral arms up, converting sunlight into energy. This inverted upside-down jelly will resettle in the muck near Florida mangroves, hidden and, like most of its kind, ignored.

The Key to Peace?

In Focus/Golan Heights

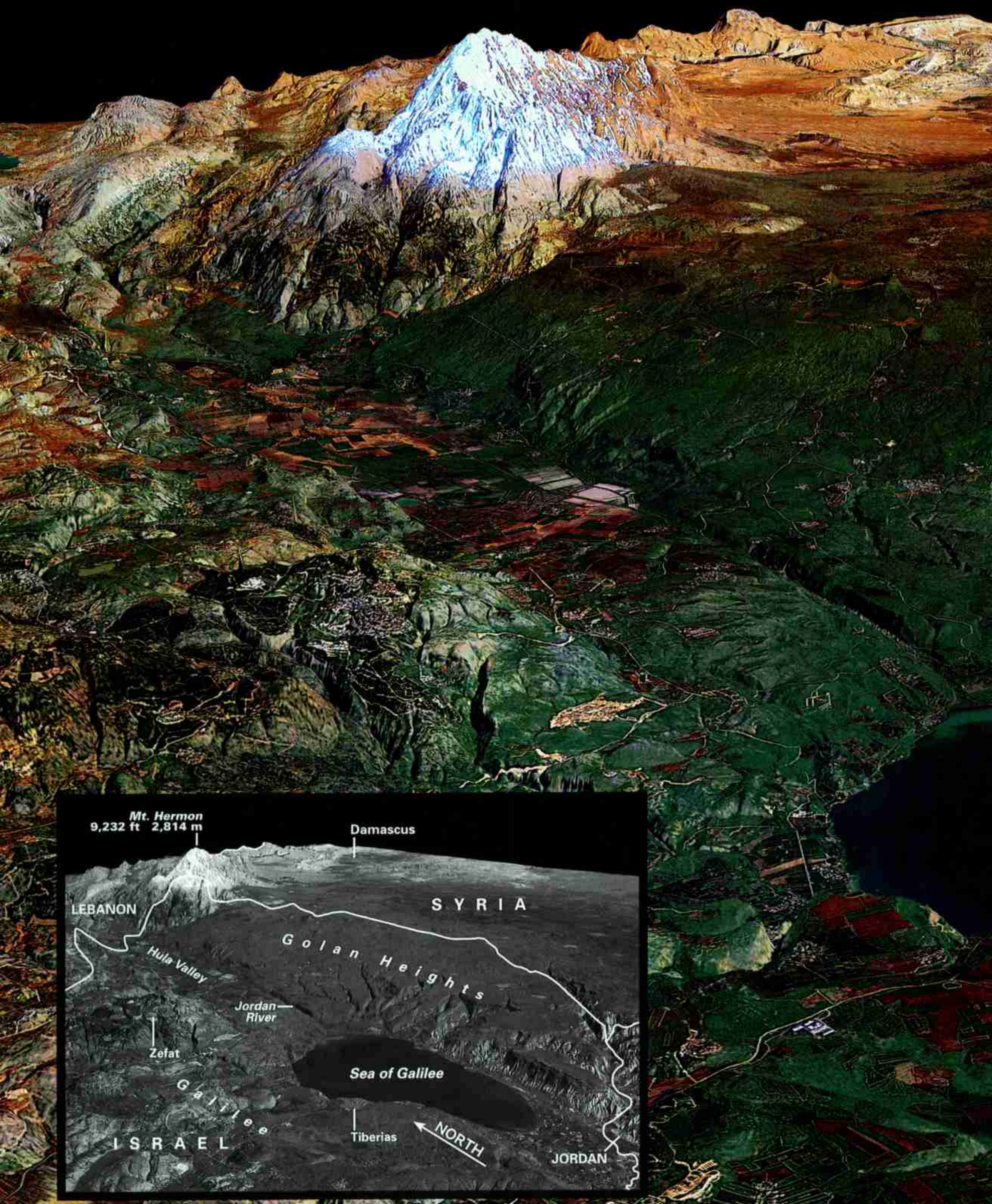


If the Golan Heights were anywhere but in the Middle East, it would merit little more than a geographic footnote. This is, after all, a sparsely populated volcanic plateau, with few natural resources and limited economic prospects. But because the Golan Heights is steeped in blood, and because it stands between longtime enemies Israel (which has it) and Syria (which wants it back), this 3,000-foot-high, 40-mile-long swath of land has a political significance far beyond its size. And as the focus of current peace negotiations, the Golan today looms larger than ever. Part of post–World War I Syria, the Golan Heights changed hands in June 1967 when Israel captured it in the Six Day War, overrunning Syrian gun emplacements as more than 70,000 people fled Golan villages. Now in ruins, the military outposts had intermittently shelled Israel's Jordan River Valley for two decades during a series of provocations from both sides of the border.

A captured Syrian fortification near Baniyas Spring on the Golan Heights offered Don Belt, far left, a vantage point overlooking Israel's Hula Valley for his June 1995 article on *Galilee*.

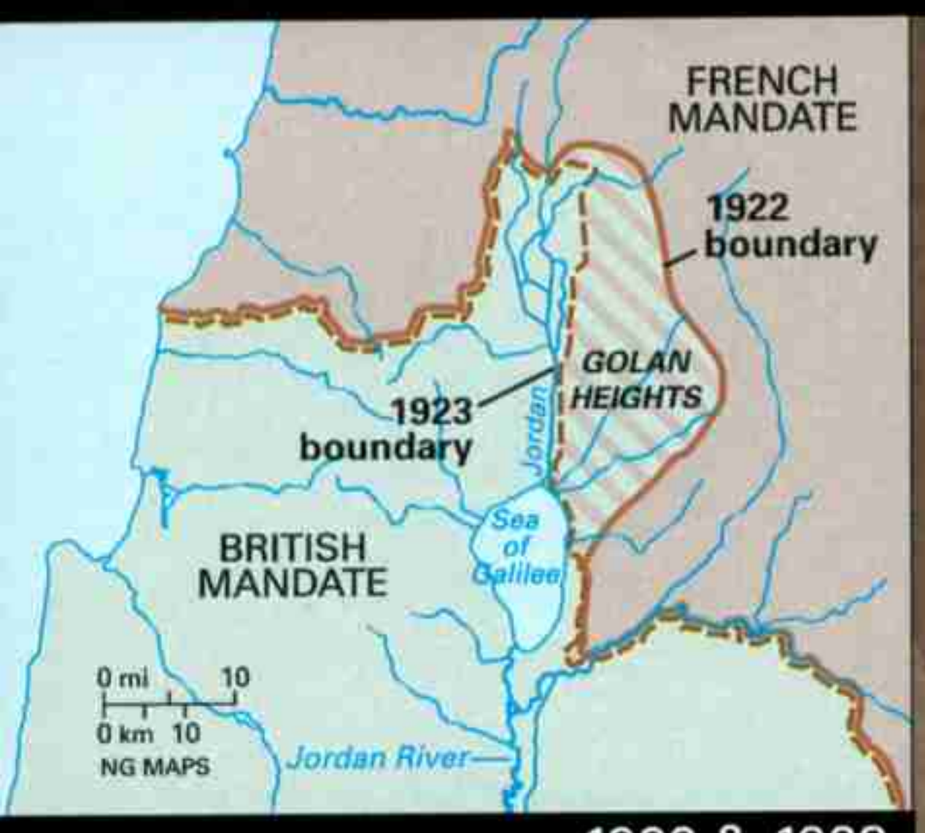
ANNIE GRIFFITHS BELT

Strategic Soil



Merging satellite imagery with topographical data that exaggerate the vertical scale three times, this computer-generated view shows the diverse geography of the Golan and environs and makes the contested region appear serene. Near the snow-draped slopes of Mount Hermon sits an array of Israeli military stations monitoring communications inside Syria. The strategic lookouts provide a view across the volcanic plateau of the Golan to the south, the fertile Hula Valley and the region of Galilee to the west, and the 25 miles of arid land stretching toward Damascus. The Sea of Galilee—7 miles wide and 13 miles long—provides as much as 30 percent of Israel's fresh water, irrigating fields that appear as patchworks of earthy hues.

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1922 & 1923

In 1922, following World War I, the League of Nations granted the Palestine mandate to Britain. In 1923 the British ceded the Golan to the French mandate of Syria.



1949

On May 14, 1948, Israel declared independence. Five Arab nations attacked the Jewish state but were defeated. In 1949, when armistice agreements were signed and Israel was delineated, Syria held on to the Golan.



1967 & 1973

On June 10, 1967, after battling Syria, Jordan, and Egypt in the Six Day War, Israel captured the Golan. On Yom Kippur in 1973, Syrian forces invaded the Golan and held it for a few days but were repulsed. Israel formally annexed the Golan in 1981.

Fighting in southern Lebanon continues between Israel—which has occupied a nine-mile-wide "security zone" since 1985—and Hezbollah guerrillas supported by Syria and Iran. Unless Israel first withdraws from the zone, as it has pledged to do, a Golan peace accord would also have to resolve this stalemate.

Mt. Hermon
9,232 ft
2,814 m

LEBANON

ISRAELI SECURITY ZONE

UNITED NATIONS DISENGAGEMENT OBSERVER FORCE ZONE

Israeli observation post

Hasbani River

Mt. Hermon Ski Resort

Metulla

Ghajar

Senir

Nimrod's Castle

Newe Ativ

Majdal Shams

SYRIA

Dan

Ein Qunya

Nimrod

To Beirut 50 miles

Masadah

Qiryat Shemona

Hula Valley

Banyas Spring

FRUIT

Buqata

Odem

VINEYARDS

El Rom

Amir

Qela

To Damascus 40 miles

Shamir

FRUIT

Lahavot Habashan

Merom Golan

VINEYARDS

Al Qunaytirah

Gonen

Shaal

VINEYARDS

En Ziwan

1923 BOUNDARY

Oretal

GOLAN HEIGHTS

DEMILITARIZED ZONE 1949–1967

Devora

Allone HaBashan

Tel Hazor

FRUIT

VINEYARDS

Qidmat Zevi

Gadot

Benot Yaaqov Bridge

VINEYARDS

Qazrin

Qazrin

Qeshet

ISRAEL

1949 ARMISTICE LINE

Aniam

FRUIT

Had Nes

FRUIT

Yonatan

VINEYARDS

Beit Saida

Almagor

Korazim

Gamla

Hiri

Maale Gamla

Capernaum

Golan Beach

Kanaf

Haspin

VINEYARDS

Ramat Magshimim

Ramot

Natur

FRUIT

Nov

Sea of Galilee

Geshur

Avne Etan

Kursi

VINEYARDS

Bene Yehuda

Eli Al

Givat Yoav

Neot Golan

Tiberias

En Gev

Afiq

Sussita

Mezar

Kefar Haruv

Mevo Hamma

Yarmuk

FRUIT

JORDAN

Deganya

To Amman 60 miles

To Jerusalem 80 miles

Jordan

- Israeli civilian settlement
 Israeli Jews settled the Golan after 1967 and created agricultural cooperatives.
- Syrian village
 All but one Syrian village in the Golan is populated by Druze, an Arab religious sect.
- Abandoned/destroyed Syrian village
- Former Syrian observation post
- Archaeological site

0 mi 5
0 km 5
NATIONAL GEOGRAPHIC MAPS

For more about the Golan Heights, go to *www.ngnews.com/golan.*





In those days the two nations also clashed over rights to the Jordan River, whose headwaters are in the northern Golan. Since winning the high ground in 1967, Israel has installed its own weapons and reconnaissance devices trained on Syria, including the capital, Damascus, just 25 miles away. To solidify its hold, Israel also began populating the Golan soon after its capture: Today 15,000 Israelis have homes here. Some 17,000 Arabs, mostly members of the Druze religious sect, also live in the Golan, stranded in a half dozen villages on the Israeli side of the border. For Syria, restoring these villages —and the rest of the Golan Heights—to its sovereignty is a matter of fierce national pride. For Israel, ceding such critical real estate to Syria is a high price to pay for normal relations and demilitarized borders on its north and east. Yet if the antagonists can work out the allocation of water resources and establish mutual security, the Golan will surely contribute to the tangled geography of peace in the Middle East. □

TEXT BY DON BELT ASSISTANT EDITOR



Waving Syrian flags in protest (above), residents of Majdal Shams, a Druze village in the northern Golan, mark the 18th anniversary of annexation by Israel. Some 17,000 Syrians remain in the Golan under Israeli rule. Just as passionate in their claims, Jewish Golan settlers demonstrated in Nazareth in 1994 (right) as Israel considered withdrawal. Today Israelis remain deeply divided over trading the Golan Heights for peace with Syria.

AGENCE FRANCE PRESSE/CORBIS (TOP); ANNIE GRIFFITHS BELT

THE IMAGE OF A WATERBIRD ON A 5,000-

YEAR-OLD POT LIVES TODAY ALONG THE

INDUS RIVER, WHERE ARCHAEOLOGISTS

ARE PIECING TOGETHER FRAGMENTS OF

IMMENSE CITIES LOST TO HISTORY.



EMERGING PAST
Peering from a decoy, a hunter lifts his head above the waters of the Indus River in Pakistan. Recent excavations reveal that in 3300 B.C. the Bronze Age village of Harappa was home to farmers, hunters, and fishermen. Within seven centuries Harappa rose to become one of at least five urban centers of the Indus civilization.

INDUS

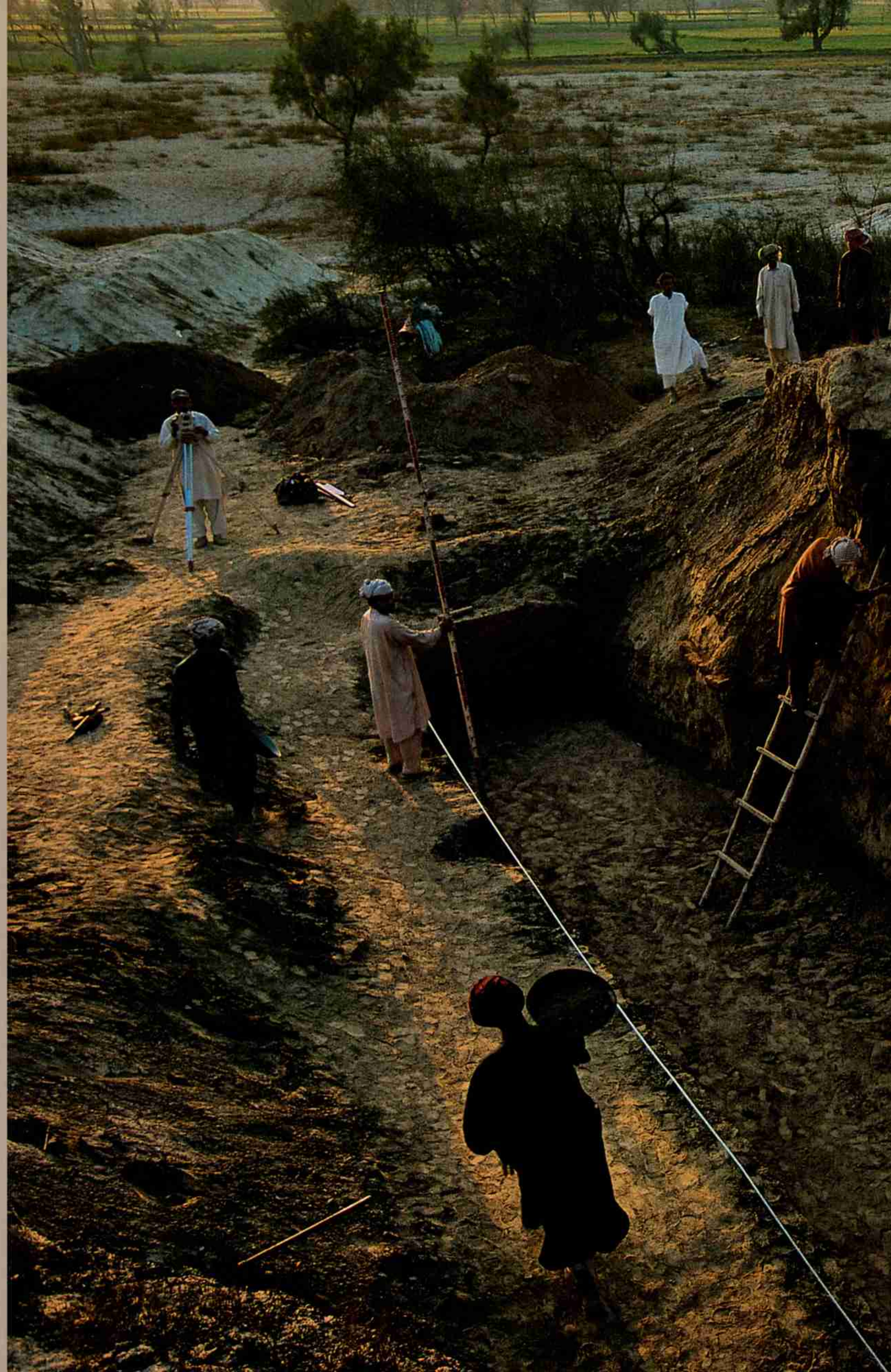
CIVILIZATION



CLUES TO AN ANCIENT PUZZLE

BY MIKE EDWARDS
ASSISTANT EDITOR

PHOTOGRAPHS BY RANDY OLSON



SLICES OF LIFE

Brushing the face of a trench cut into Harappa, excavators examine layers deposited in the city's early years. The site allows a look at the full span of Indus civilization—from its beginnings to its disintegration after 1900 B.C., following centuries of wealth and power.

SEVEN O'CLOCK on a May morning in Pakistan. The sun arcs across a cloudless sky and the temperature climbs; by noon it will reach 110°F. On all fours in a pit, archaeologist Richard Meadow probes secrets hidden for some 40 centuries, deposited by the builders of southern Asia's first cities.

RESEARCH PROJECT

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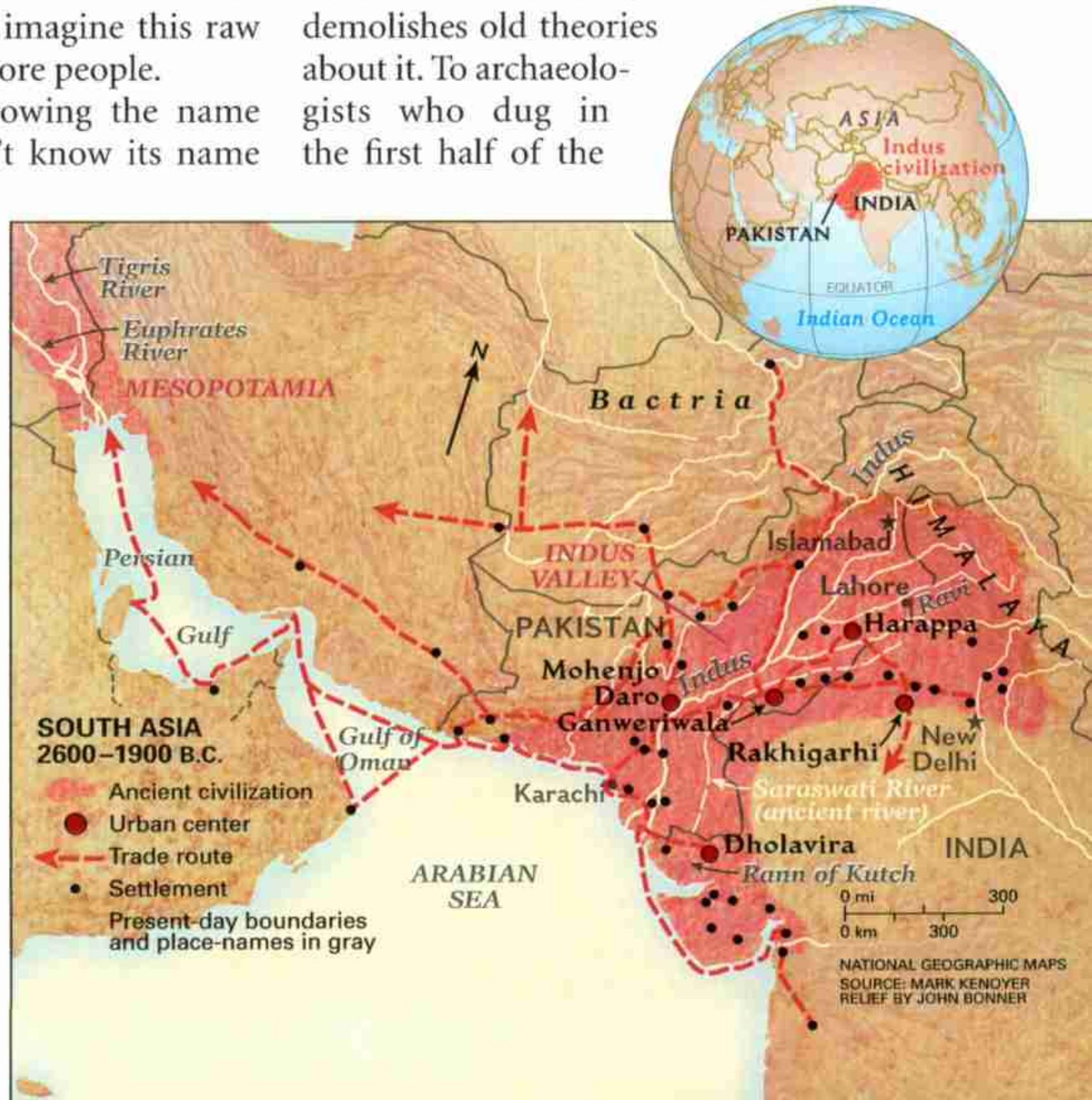
A few feet below him in the excavation, Meadow's colleague Mark Kenoyer uncovers a tracery of bricks. All around, turbaned laborers shovel and scrape. A bucket brigade passes earth to other laborers, who sift it in fine-mesh screens, occasionally retrieving potsherds and other small objects.

I climb to the top of a mound and gaze out at the tawny plain of Punjab province. Men and women toil with sickles, felling ripened wheat. Water buffalo amble into a pond. The mound beneath me and other mounds nearby are starkly incongruous in this bucolic setting. They rise like a clutch of low hills, and though their height is only 50 feet, they command the level countryside. Their earth is almost naked, relieved occasionally by copses of acacia and tamarisk trees. It is hard to imagine this raw place as a city of 20,000 or more people.

Harappa we call it, borrowing the name of a modern town; we don't know its name in antiquity. Nearly 400 acres in size, it was one of the largest cities of a civilization that flourished from 2600 to 1900 B.C. along the Indus and other rivers in Pakistan and India. Harappa was probably one of many urban centers linked by trade and kinship that made up what is usually known today as the Indus civilization. The Indus territory was a Texas-size quarter million square miles, reaching from the Arabian Sea north to the Himalayan foothills and east to New Delhi.

The Indus people employed the wheel for transport as well as to turn pottery, and they were the first to make large-scale use of fire-hardened bricks in construction. Like the people of Mesopotamia, whose cities rose a few centuries before Harappa, they also had a writing system; archaeologists have unearthed thousands of examples of the script. Despite the efforts of many scholars, however, the symbols have yet to yield a credible sentence—a major reason that the Indus culture, surely one of the greatest of the ancient world, has remained vexingly obscure.

Still, years of work by Meadow, of Harvard University, and Kenoyer, from the University of Wisconsin, have produced a picture of Harappa that broadens and deepens our knowledge of the Indus culture, and demolishes old theories about it. To archaeologists who dug in the first half of the





INDUS HEARTLAND
The glazed tiles of a 17th-century mosque in Lahore echo the brilliance of Harappan artisans. Fine craftsmanship is a hallmark of Indus culture, which covered an area twice the size of ancient Egypt and supported trade networks stretching from present-day India to Syria.

20th century, "the Indus civilization appears to spring into being fully grown," as one wrote. He thought it might have been inspired by Mesopotamia, 1,500 miles to the west. But recent excavations prove that a village stood at Harappa's site in 3300 B.C., or 700 years before the advent of the city's great era, 2600 B.C. Moreover, several potsherds bear symbols that may prefigure the Indus script; they suggest that the people were inscribing symbols far earlier than archaeologists thought—at about the time the Mesopotamians developed what is believed to be the world's first writing system.

Photographer RANDY OLSON has previously covered U.S. subjects for the magazine. This is his first archaeology assignment. He won the Robert F. Kennedy Journalism Award for documenting social ills in 1991.

IN THE PIT Meadow picked his way to the core of an earth-encrusted lump, which proved to be a large bone. A specialist in zooarchaeology, he recognized it as an elephant's mandible, at which I expressed surprise. "There were elephants around here," he said, "and the people hunted them to get ivory to make ornaments." Harappans may also have tamed elephants for heavy labor. In another excavation the archaeologists found a small terra-cotta elephant's head painted white and red, colors that Indian mahouts still daub on working pachyderms.

Kenoyer regarded the row of half a dozen bricks cleared by his trowel—a "ghost wall," he called it. "There was a building here," he assured me. "But when we dug in, there were

just these few bricks and a big void with earth and trash washed in."

Harappa's kilns turned out millions of bricks, a feat that led, in modern times, to a woeful scrambling of archaeological evidence. Needing ballast for a new track, British railroad builders in the 1850s sent laborers into the ruins to root out the bricks and cart them away. Afterward archaeologists who dug at Harappa figures that may be deities. Other seals depict animals, such as the humped zebu bull, still common in the Indian subcontinent.

Many of these pieces were used to stamp impressions on clay rectangles, probably for attaching to trade goods to show ownership. Others may have been identification badges of a sort, proclaiming the wearer's membership in a particular community.



concluded the earth was too disturbed to yield a coherent account of the city. In fact, no one had excavated at this chaotic site for 20 years when, in 1986, a team arrived from the University of California at Berkeley, led by George Dales and Kenoyer. Meadow joined them in 1987 and became co-director with Kenoyer after Dales' death in 1992. Their Pakistani partner is that nation's Department of Archaeology and Museums.

Though disheveled, Harappa's earth is yielding artifacts that greatly amplify what is known about the life of the people. The most intriguing artifacts are postage-stamp-size seals, usually of stone, that bear writing and carved

Also significant are things *not* found: no remains of great temples such as Mesopotamia's or sumptuous tombs such as ushered Egypt's pharaohs to the next world. In other words, no evidence of an overweening kingship or theocracy. "Rather, what we see in Harappa is an elaborate middle-class society," Meadow said. The archaeologists wonder if Harappa even had an army. Although a few weapons have been unearthed, no carved pieces depict war scenes like those in the sculpture and texts of Egypt and Mesopotamia.

Other finds testify that Harappa was a city of craftsmen and traders. Its merchants probably sent goods to other Indus urban centers—five

cities have been discovered—and also to Oman and the Persian Gulf region. Working several kinds of stone, gold, and silver, artisans turned out exquisite jewelry. Traders supplied them with raw materials such as lapis lazuli from what is now Afghanistan. From the Arabian Sea, 500 miles to the south, came conch shells to be sawed into bangles.

Perhaps the finest examples of Indus craftsmanship were long beads of carnelian, a grayish yellow agate that changes to an orange-red color when baked in a kiln. The artisans not only knew how to achieve this prized hue but also used drills of copper alloy or hard stone to bore string holes through four-inch carnelian cylinders. Archaeologists have found Indus carnelian in Mesopotamian tombs.

HARAPPA's five large mounds grew over the centuries, for the people were continually raising houses and laying streets over the constructions of their ancestors.

Thus far the archaeologists haven't found the remains of a wall surrounding the city; perhaps there wasn't one. "But what's peculiar is that each mound had a wall," Kenoyer said as we climbed one of these hill-like elevations. "They weren't built for defense. Look," he added, pointing to a neighboring mound, "you could shoot an arrow from here across to that one." Reckoned to have been about 20 feet high, the walls may have been constructed to prevent flooding by the Ravi River, an Indus tributary that once flowed near the city. Kenoyer thinks the walls may also have defined areas occupied by particular groups of artisans or merchants. That settlement pattern is still followed in the subcontinent, with several members of, say, a metalworking family setting up their shops in one bazaar.

"We learn a lot about Harappa by just looking around us," Kenoyer said. He looks with discerning eyes, having grown up in India, the son of American missionaries.

Indeed, the people around Harappa may live and work much as the ancients did. Some local people believe Harappa's builders were their ancestors, although that proposition is difficult to test scientifically, and in any case the subcontinent has witnessed much migration over the centuries.

By Kenoyer's estimate ancient Harappa controlled a region of 50,000 square miles, as large as New York State, and from this sprawl of plain drew its sustenance. "Skeletons show that the population was probably well nourished," Meadow told me. "Meat seems to have been generally available, to judge by the animal bones we've found." The people had cattle, sheep, goats, and water buffalo—all common in the countryside today—and also dogs and chickens. Charred kernels found by hearths and in trash deposits prove that they also had wheat and barley, still important crops.

Sometimes I went into the countryside with Nasir Ali Dhillon, a schoolteacher who lives in Harappa town. Nasir provided the transport—his motorcycle. I'd climb on behind, and off we'd go. Sometimes we didn't see an automobile for miles.

One day we came upon a farmer plowing

CLAY OFFERINGS

Harappans left no monuments to their religion, only what archaeologist Gregory Possehl calls "small, modest, even humble expressions of human sentiment." This figurine may have served as an offering, like the terra-cotta horses (above left) brought to a Lahore tomb by people hoping their prayers would be answered.



with a team of zebu bulls like those carved on Indus seals 4,500 years ago. On their necks were strings of blue beads and small brass bells. "That's to make them look beautiful," the plowman said affectionately.

Another farmer, Naseer Ahmad Tullah, assured me that the zebu is far smarter than the water buffalo, which also is used for farmwork. "Zebus are geniuses," he said. "They understand my language. When I say *hethan, hethan,* they go left, and when I say *uttan, uttan,* they go right."

While we sat in his yard, shaded by an acacia, a barber arrived to trim my host's dark beard and also the beards of his two sons. No money changed hands; instead, after the wheat harvest, the barber would be paid in grain for his occasional visits.

Many workers in traditional occupations are compensated in this way. When Nasir and I stopped in Harappa town to watch a potter at work, he did not rise from his wheel to welcome us. With the wheat harvest in full swing, Fateh Mohammad was busily shaping pots to take to farm families—cooking vessels, churns, urns. In return Fateh's storeroom would soon brim with wheat, which he would sell to townsfolk. Fateh supplies pots to families that were his father's clients, for this barter-like system is hereditary. Kenoyer believes a similar relationship existed between worker communities in ancient Harappa.

While no potter's wheel has been found, Kenoyer is certain that artisans used it to produce their perfectly rounded vessels. Fateh believes his foot-powered wheel is different in only one regard. "Where the spindle turns, potters used to use a strip of oiled leather for a bearing," he said. "I use a bearing from an old car."

His hands coaxed a clay lump into the shape of a large bowl. Another lump, another bowl. Presently he would pack 200 vessels into a kiln and surround them with enough dried animal dung to smolder for three days—just as firing was done 45 centuries ago in the Indus Valley.



DINNER at the archaeologists' camp, a collection of simple buildings, brought together Meadow, Kenoyer, and several U.S. and Pakistani graduate students. At the meal's end Kenoyer rose and reminded the students, "Tabbing tonight." Presently they drifted to a laboratory to tabulate the day's finds.

A pile of plastic bags contained objects sifted from excavated earth. One held two stoneware bangle fragments bearing a delicate clover-like design in red and white. Another item was a black stone about the size of a thumbnail. Puzzled, Kenoyer held it to a light, then exclaimed, "Boy, this is the most interesting thing we've found in a long time!" It was a tiny carved headdress or wig, made for a statue perhaps six inches tall.

Carved stone statuary of any size is rare at Harappa, and obviously this statue was



MASS PRODUCTION
Raising a plume of dust, a worker near Lahore digs newly fired bricks from a flaming pit. Building where stone was scarce, Harappans manufactured millions of similar bricks in uniform proportions for the foundations of cities they raised above the floodplains.

a work of art; the wig was so meticulously sculpted that I could make out hair strands. There were sockets for attaching the piece to a head. Kenoyer speculated that the statue was created by a Harappan artisan. Meadow, however, pointed out that small statues like this, made of different stones, were fashioned in 2000 B.C. in Bactria in the region of northern Afghanistan. "I think it shows the connections between Harappa and Central Asia," he said. "The statue could have come in trade."

Whatever its origin, the piece underscores how Harappa's elites—landowners, religious leaders, and, perhaps, a ruler—appreciated small treasures. "If you were a rich merchant, you didn't have to build a huge palace to impress the other elites," Kenoyer said. "You had a beautiful little sculpture that





NATIONAL GEOGRAPHIC ARTIST CHRISTOPHER A. KLEIN

people saw when they came over for dinner."

The bags opened at tabbing sessions sometimes contained diminutive terra-cotta figures, which seem as plentiful at Harappa as stone statues are scarce. I spent an afternoon with Sharri Clark, a Harvard doctoral candidate who was studying them. To judge by the detail on some of the figures, Harappan women fairly dripped jewelry. "Look—three necklaces," said Clark, handing me a sculpture. Three strands of clay draped the formidable bosom of this four-inch-tall example. Other females were adorned with chokers, belts, and pendants.

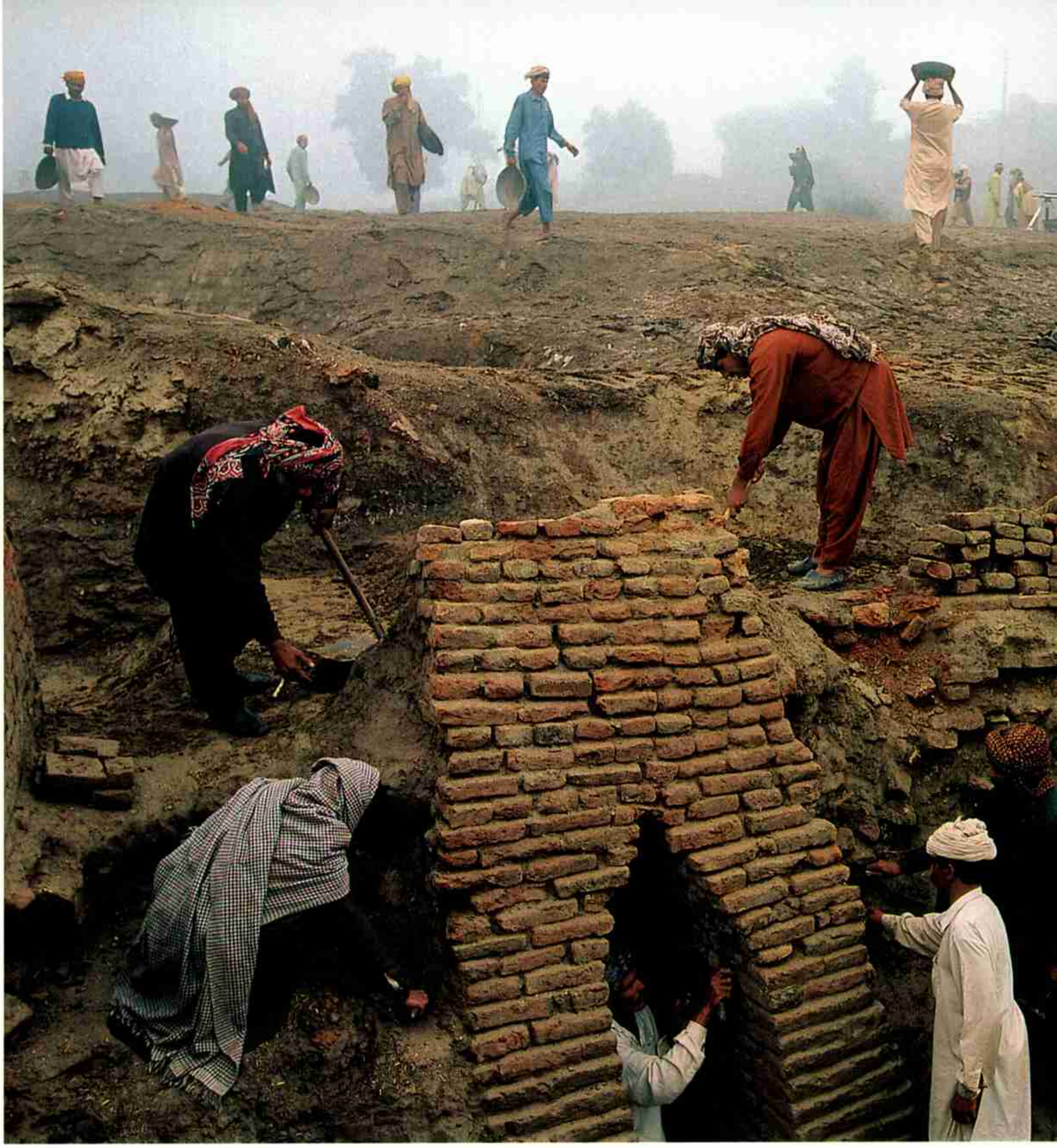
"Mother goddess" is a term that some archaeologists apply to such figures, assuming they were meant to be worshiped. "I would agree if we had found these in a temple or some other ritual context," Clark said. "But most of these pieces were found in trash, as if they'd been thrown away." Some scholars have suggested that the figures were toys—the Barbie dolls of the third millennium B.C. While acknowledging that possibility, and that some pieces may represent supernatural beings, Clark suggests that others may represent real people who were wealthy or powerful.

The Indus culture was devoted to small things. More than 60 sites have yielded seals and tokens of stone, copper, silver, bone, terra-cotta, or ivory. Still others were made of faience, powdered quartz that was molded, then fired to a glassy finish.

These bear a trove of information. One terra-cotta token, for example, shows a boat with sharply rising prow and stern, much like vessels plying the Indus today. And numerous artifacts depict bizarre figures—humans with horns like a bull's or a water buffalo's—that the archaeologists believe also represent deities or supernatural power. "When I was a kid growing up in Assam, I had a friend whose mother was in a tiger clan," Kenoyer said. "I heard stories about her turning into a tiger at night and roaming the jungle. So when I saw figures here with a human face on a tiger's body or a bull's

CEREMONIAL GATHERINGS

Grand processions, like this one, are depicted on Harappan tablets. Archaeologist Mark Kenoyer believes that such events elevated the status of merchants, landowners, and spiritual leaders, enabling them to rule Indus cities through control of religion and trade.



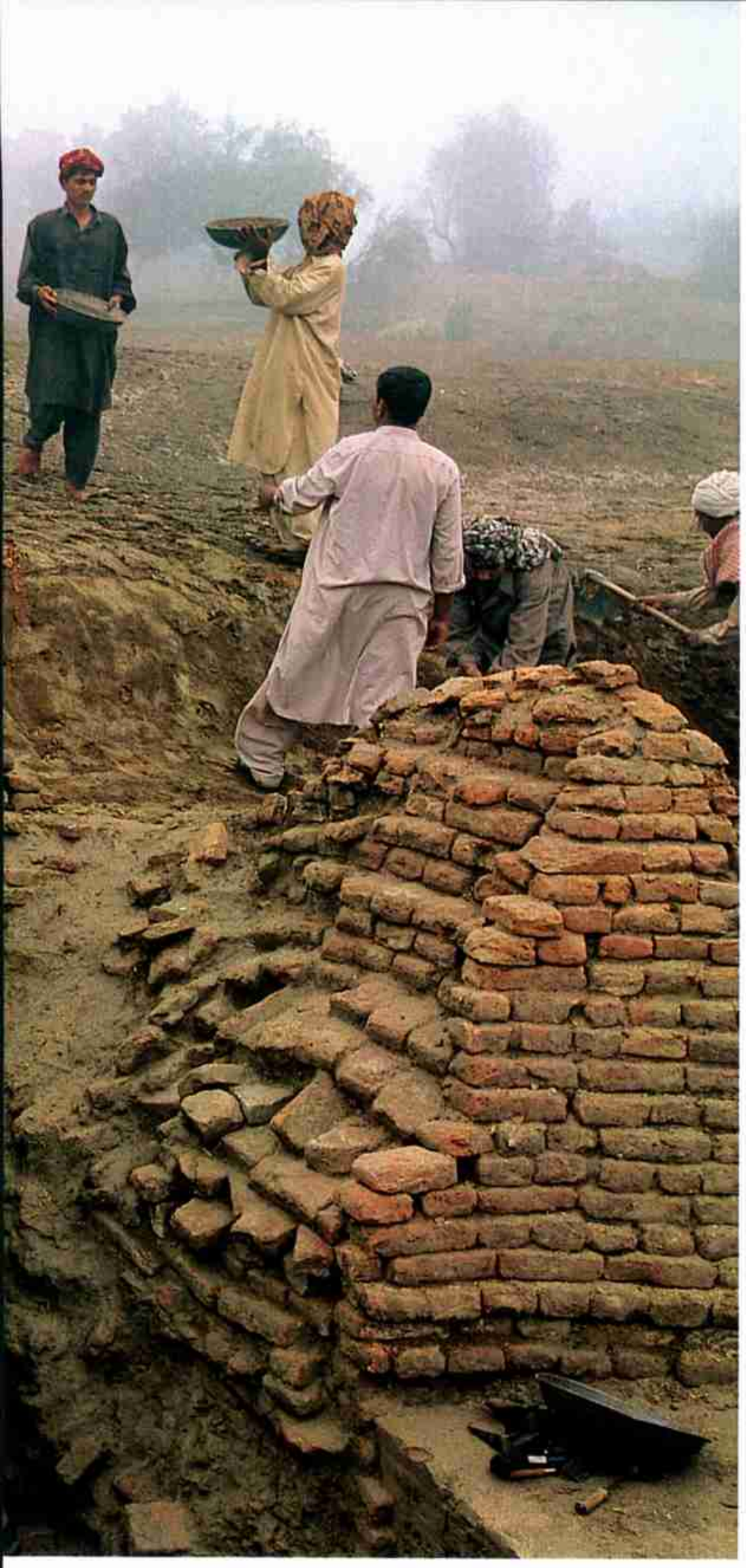
body, it was something I could understand."

On one token, what appears to be a human head is being set before a horned figure like an offering. Some scenes are embellished with the heart-shaped leaves of the pipal tree. Humans bow before the tree, and figures that may be deities stand under arches of pipal leaves. This is one of many examples of Indus symbolism that survive, for the pipal is a symbol of fertility and protection in Hindu mythology.

Among the animals carved on seals and depicted on tokens are the rhinoceros, crocodile, and elephant. But the one most often depicted is imaginary: a unicorn. Pieces with one-horned animals have been found throughout the Indus realm, leading Kenoyer to believe the unicorn was the symbol of a powerful community, perhaps a ruling one. Some seals had a boss on the back, pierced as if the piece was to be worn on a string.

Many bear the Indus script, perhaps giving the owner's name or group name. Some of the graphemes look like familiar objects—a fish, for example, or a bull's horns.

Archaeologists have counted more than 400 different symbols, inscribed on seals, potsherds, and other surfaces. The longest inscription contains 26 symbols, but the average is just five—not much for a decipherer to work with. Some linguists believe the language



belongs in the Dravidian family, which includes Tamil and about 25 others still spoken in the subcontinent. But the script is unlike any known writing system, and some archaeologists despair that it will ever be understood.

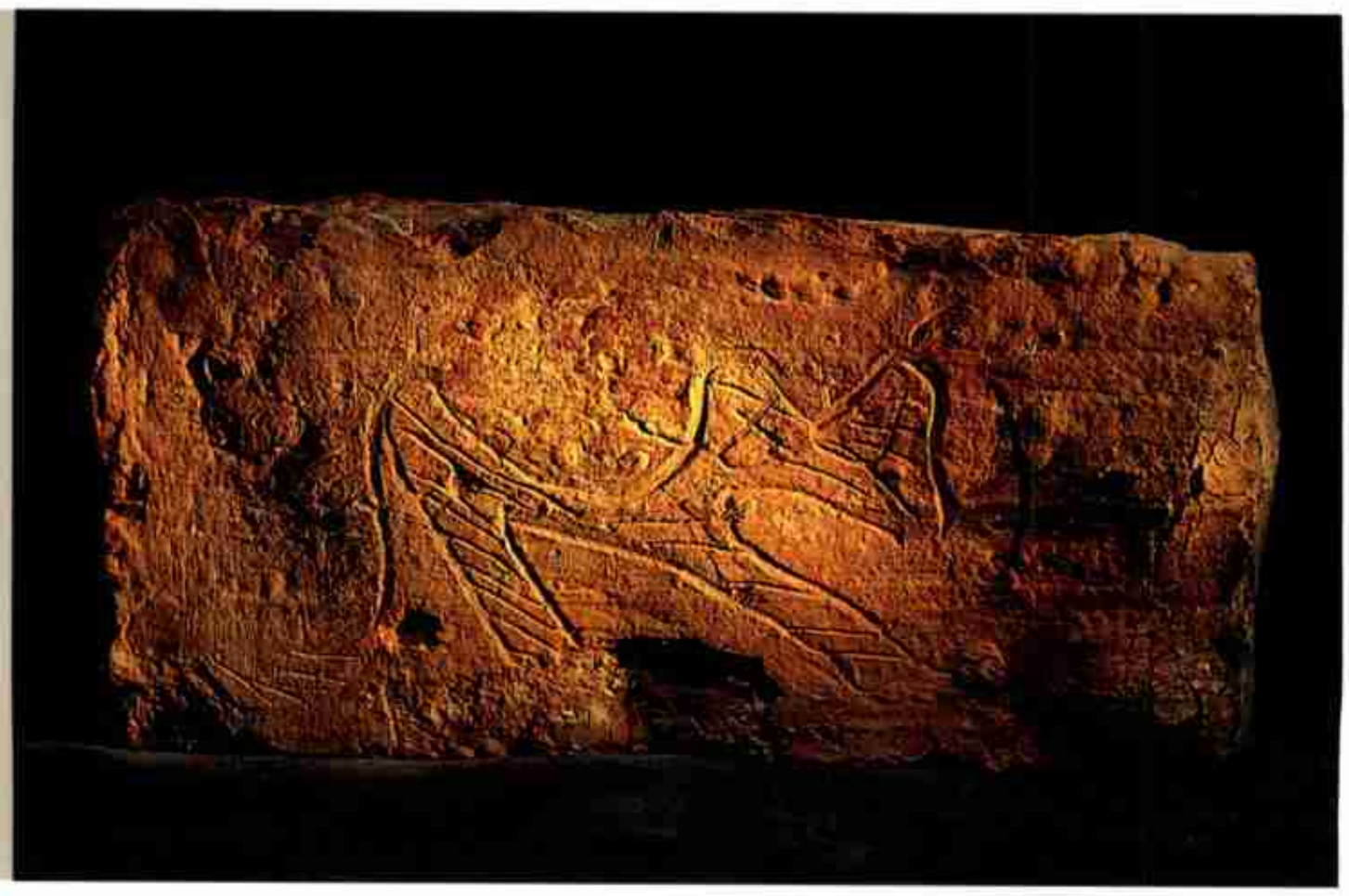
One possible clue to the script's origins is a potsherd found in an excavation near the base of one of Harappa's mounds. Charcoal recovered at that level and dated by the carbon-14 method shows that people lived there about 3300 B.C., or 700 years before Harappa flowered into a city. The sherd was inscribed with three symbols that look like tridents. Were the Harappans writing as early as 3300 B.C., or were these marks idle graffiti? "I don't think we can call it writing," Meadow said. "It's a sign or a symbol"—but an intriguing symbol, for the trident frequently appears in later Indus script.

Nearby excavations revealed much about the earliest occupation of Harappa's site. "Can you see the slight changes in the color of the soil, those circles?" asked Muhammad Afzal Khan, a Pakistani archaeologist who was digging there. I picked out several circles slightly darker than the buff-colored surrounding soil. "Probably postholes for huts," he said. No bricks were being fired for house building in 3300 B.C. "But that dark red streak," he continued, pointing to a corner of the excavation, "may have been where there was a kiln."

Perhaps that kiln fired the bead of faience discovered close by. Even at this early stage artisans possessed the technology to transform a paste of powdered quartz into a glassy bauble. Sifted earth also yielded beads of lapis lazuli, probably from Afghanistan; green amazonite, perhaps from Gujarat state in India;

BRICK MINE

Most bricks, such as one inscribed with an animal (right), were looted from Harappa, but the sewer system remained for archaeologists to excavate. Digging down to the level of an ancient drainage channel, workers uncovered a brick culvert (above) that once carried water out of the city.



PIETY AND PROFIT

With fervent devotion a Muslim mendicant dances in Lahore. Religion

and commerce likely mixed in Indus cities during crowded fairs that gave merchants a ready market.

and bangles made from Arabian Sea shells. Even some 53 centuries ago the people were linked in a vast trade network.

MUCH OF HARAPPA'S TRADE undoubtedly traveled on the Ravi River, eventually reaching the Indus. And some of it surely went by that main-stem river to Mohenjo Daro, Harappa's sister city some 400 miles to the south.

Harappa's neighborhoods must have resembled those I walked through in Mohenjo Daro, along streets tenement-dense with brick buildings ten feet tall. It is a lonely place, standing solitary in a landscape of grainfields. The Indus is a streak of silver in the distance. Excavations exposing more ruins were halted in the 1960s because the bricks unearthed by digging began to crumble.

The problem is salt, mortal enemy of bricks. Under a blanket of eroded sediment Mohenjo Daro's bricks survived very well. But when the earth was removed in excavations, the hot sun and wind dried the surfaces of the walls, thus wicking out the salt-laden moisture in the bricks, causing them to disintegrate. Some of those walls have now been re-covered.

Archaeologists guess that the city occupied about a square mile, though only a small part has been excavated. Among the 300 visible structures is one called the Chief's House, since it is the largest dwelling found. From its spacious foyer I walked into a courtyard surrounded by rooms. Counting the courtyard, the house covers more than 8,600 square feet, four times as big as the average American home. And it may have had a second story.

EXCHANGE RATE

Traders from the north wait to present turquoise and lapis lazuli to a Harappan merchant weighing beads (right). Since the Indus civilization lacked a currency, standardized weights enabled tradesmen to barter and may also have helped officials assess taxes.

The smallest houses that archaeologists uncovered had two rooms. Actually, two rooms with bath. Brick bath platforms, a yard or so square, are ubiquitous in Indus cities, suggesting that the people made bathing a ritual, as many still do in southern Asia.

Toilets also have been found, with brick supports for seats. Effluent sluiced to a brick-lined sewer or to a buried urn. "The Indus people were quite advanced in their toilet arrangements," Meadow had said in Harappa. Their devotion to plumbing far exceeded that of the Egyptians and Mesopotamians.

About 2200 B.C. Mohenjo Daro's people built what archaeologists regard as the most spectacular feature yet discovered—a pool 39 feet long, 23 feet wide, and 8 feet deep. The brick walls were sealed with bitumen, and the floor was slanted toward a corner drain. I descended one of the two flights of steps into this commodious tank, as people presumably had done 4,000 years before.

As with Harappa, we don't know the true name of this city; Mohenjo Daro is a modern appellation that an archaeologist translated as: "Mound of the Dead." Early archaeologists

STUBBORN PUZZLE

Unable to decipher Indus script, archaeologists have traced its development back in time. Pottery found at Harappa dating from 3300 to 3000 B.C. carries signs scratched into the surface (below) that resemble a trident-shaped character on a seal used centuries later (right, second from right in line at top). Scholars agree that the script is generally read right to left and that characters stand for words, syllables, or sounds. Beyond that, having only short passages and no Rosetta stone, scholars offer contradictory translations. Gregory Possehl's review of three dozen attempts to crack the code is pessimistic: "Everyone is guessing . . . 99.9 percent is probably useless speculation."



RICHARD H. MEADOW © HARAPPA ARCHAEOLOGICAL RESEARCH PROJECT





CHRISTOPHER A. KLEIN

certainly thought of it that way, concluding that the city's end—and the end of the Indus civilization—came at the hands of invaders sweeping down from Central Asia.

Prompted by the discovery of some 30 skeletons in the ruins, Sir Mortimer Wheeler, dean of subcontinent archaeology in the 1940s and 1950s, wrote that "men, women, and children were massacred in the streets and houses, and were left lying there or, at the best, crudely covered without last rites." To Wheeler the "massacre" tracked with verses in the Rig-Veda, a collection of ancient Hindu hymns that recounts the destruction of cities by the fierce and warlike god Indra.

Today archaeologists point out that no weapons or other evidence of an attack were found at Mohenjo Daro. Some believe the skeletons were of persons who died of disease. And many archaeologists doubt that there was an invasion. Examination of skeletons from Indus cemeteries has failed to show that the original people were supplanted by newcomers with different characteristics.

No one can say with certainty why the subcontinent's long-lived civilization came to an end, but Kenoyer suspects unruly rivers. "I think the fluctuations of the Indus had a major impact on Mohenjo Daro," he said. "It whipped back and forth across the plains, causing floods

that destroyed the agricultural base of the city. Trade and the economy were disrupted." That may have happened at Harappa too. Hundreds of villages may have been destroyed by floods or by rivers carving new channels. Other villages were abandoned after the Saraswati River, a major stream flowing parallel to the Indus, went dry, its main tributaries having shifted into other river systems.

Rann of Kutch, a desiccated marsh periodically flooded by the Arabian Sea.

"Maybe salt was a commodity they sold," said R. S. Bisht, of the Archaeological Survey of India, who is the chief investigator at Dholavira. That is one theory for the presence of such a large city in this harsh place. Some scholars think Dholavira might have been a port or a fort protecting sea trade with Oman and the



A POLITICAL GULF separates the archaeologists of Pakistan and India. Though they meet at international conferences, few have seen one another's sites. The red tape involved in official visits between these hostile nations is formidable, even for scientists. Dholavira, India's most spectacular Indus civilization site, happens to be particularly sensitive. It's in an area 30 miles from the border and patrolled by the military.

From its ruins I looked out at salt pans gleaming like snow. Dholavira was a walled city occupying about 120 acres on an island stippled with thornbush and cactus in the Persian Gulf. Today no navigable channel joins Dholavira with the sea, but one might have existed when the city arose, about 2500 B.C.

Bisht is an enthusiastic, bookish man behind thick glasses. "Look at it!" he exclaimed as we walked on a wide street flanked by walls of sandstone and limestone. "They produced so much building material—it's amazing!" These dwellings were colorful. Walls and floors were coated with clay—white, buff, pink, red, purple. In one floor excavators dug through a foot-thick clay layer consisting of 37 coats.

On another day I watched crews excavate a huge stone-lined cistern. Men dug, and women (often laborers in India) bore away the debris,

walking gracefully with laden pans upon their heads. Their saris and veils—red, orange, yellow—lit up the sere countryside.

Numerous reservoirs were scattered about Dholavira, and some may have been used for ritual bathing. But mainly, Bisht said, "The people were thinking not to let a single drop of water escape." No freshwater river flowed into the salty coastal regions; hence Dholavira must have relied heavily on the monsoon rains. Two gullies near the city were dammed to catch water when it came; ditches diverted it into reservoirs.

Dholavira's primary mound, rising some 50 feet with massive stone walls, looks like a fortress. This is where the ruler lived, Bisht believes. "He was displaying his pomp and show. Otherwise, why were these enormously thick walls here?"

Bisht does not disagree with Kenoyer and others who view the Indus civilization as a kind of economic empire composed of city-states with a shared culture. Indeed, Dholavira has yielded artifacts identical to those found at Harappa and Mohenjo Daro, such as the unicorn tokens. But while Kenoyer speaks of power shared by a coterie of landlords, religious leaders, and traders, Bisht views Dholavira as the creation of a strong monarch. "He had to have vast resources to build such a city," he said. And, judging by the quantity of labor necessary to construct the citadel, cisterns, and city walls, Bisht believes there must have been slaves.

One of the gates leading into the citadel was surely monumental. Bisht found limestone slabs two feet thick and eleven and a half feet long, expertly squared and smoothed. In the earth by this gate he also found what seems to have been the remains of a signboard. Ten 15-inch-tall symbols, made of gypsum paste in such shapes as a spoked wheel and a diamond, were still visible. Perhaps this was a legend proclaiming the might of Dholavira's lord.

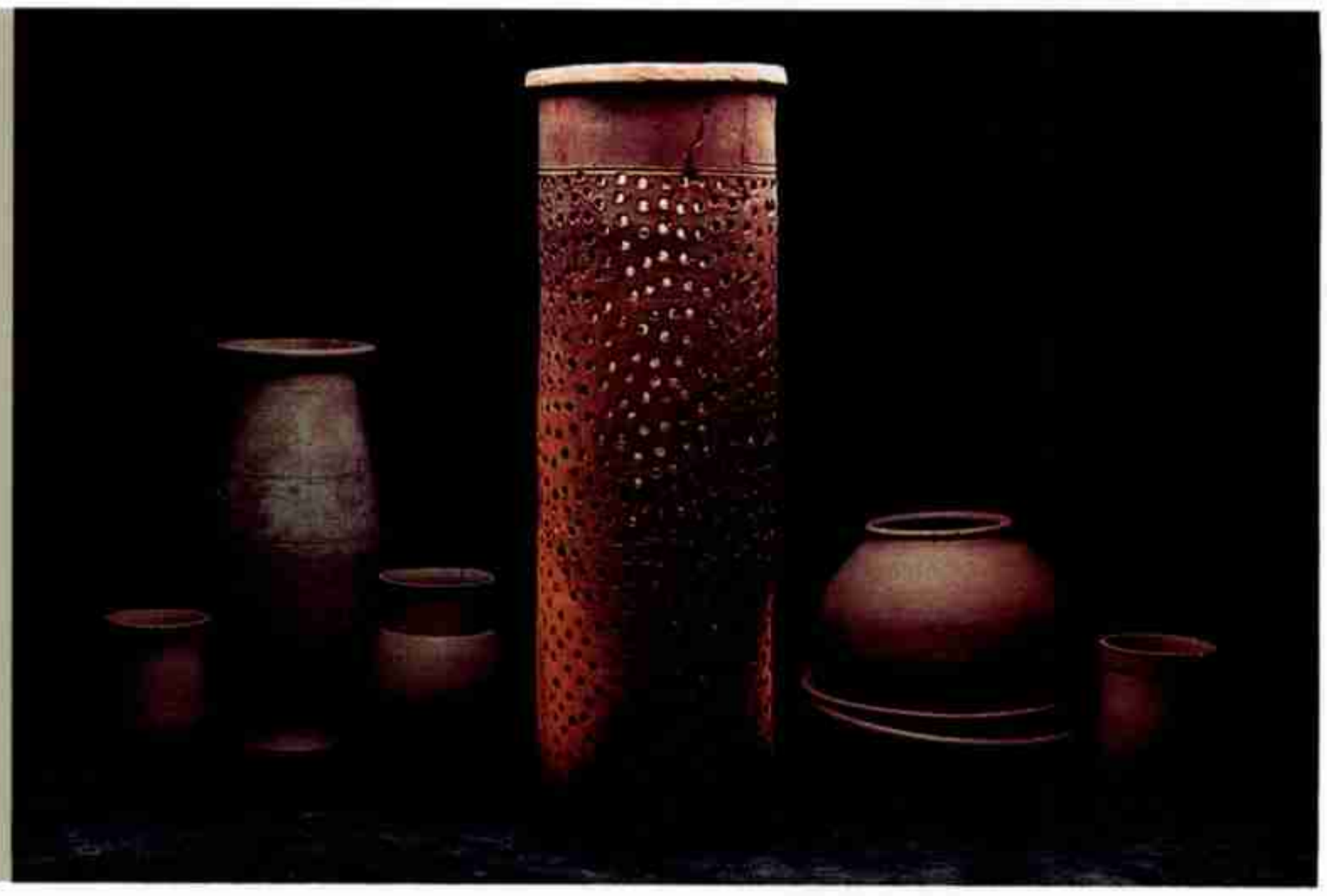
In about 2000 B.C. the quality of stone masonry became haphazard at Dholavira, indicating that the city was in decline. "This coincides with a time of war and turmoil in Mesopotamia," Bisht said. "The transportation system was disrupted. Trade must have fallen off. The easy wealth was no longer coming in." Eventually Dholavira was abandoned.

The Indus script might confirm such theories, if only it could be unlocked. Many other riddles must be solved before we can chart the odyssey of the industrious, orderly people of this civilization. Why, for example, did the unicorn vanish as a symbol in the subcontinent after the civilization's collapse? Why did the script vanish? Kenoyer suggests that these trappings of authority came to be associated with terrible events. "The land is flooded, the economic system fails, and so the people who ruled lose their power," he theorizes. "The next rulers don't want to be associated with bad things, so the old symbols are expunged."

Perhaps the Indus civilization will never come into clear focus. "To try to solve all the riddles is like picking up pebbles on a seashore," Bisht said one day. Still, there are not quite as many pebbles to pick up as before.

INDUS INFLUENCE

Provision for the afterlife, a cylindrical strainer (right), probably used in making beer, was entombed at Harappa. In Dholavira, far to the south, bracelets adorning the arms of women resemble bangles found in Indus burials. Archaeologist R. S. Bisht believes ancient Dholavira functioned as a colony—a Harappan trade outpost on the coast.



ETERNAL RHYTHMS

Timeless chores require walking miles to reach waters that once flowed



near Harappa. Shifting rivers and eroding institutions likely doomed Indus cities to mute ruins. □



TOPICAL PRESS AGENCY

■ FROM THE GEOGRAPHIC ARCHIVES

A High Tea

London ladies in 1932 picnicked on the rooftop of Adelaide House—which then boasted a fruit and flower garden and an 18-hole putting green—overlooking the Thames' Tower Bridge. In February of that year the GEOGRAPHIC published "Some Forgotten Corners of London," in which author Harold Donaldson Eberlein had less success with the region's cuisine.

"With the striking variety of . . . vegetables that can be successfully grown in almost any part of England," he wrote, "the absolute domination of cabbage and potatoes in the average British regimen appears totally inexcusable."

This photograph has never before been published in the magazine.

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(OMEPRAZOLE) 20-MG CAPSULES

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Please read this summary carefully, and then ask your doctor about PRILOSEC. No advertisement can provide all the information needed to prescribe a drug. This advertisement does not take the place of careful discussions with your doctor. *Only your doctor* has the training to weigh the risks and benefits of a prescription drug for you.

Prilosec®* *(omeprazole)*

Delayed-Release Capsules

BRIEF SUMMARY. Before prescribing, please consult full Prescribing Information.

CLINICAL PHARMACOLOGY, Pharmacokinetics and Metabolism: Omeprazole In pharmacokinetic studies of single 20 mg omeprazole doses, an increase in AUC of approximately four-fold was noted in Asian subjects compared to Caucasians. Dose adjustment, particularly where maintenance of healing of erosive esophagitis is indicated, for the hepatically impaired and Asian subjects should be considered.

INDICATIONS AND USAGE, Duodenal Ulcer: PRILOSEC is indicated for short-term treatment of active duodenal ulcer. Most patients heal within 4 weeks. Some patients may require an additional 4 weeks of therapy. PRILOSEC, in combination with clarithromycin and amoxicillin, is indicated for treatment of patients with *H. pylori* infection and duodenal ulcer disease (active or up to 1-year history) to eradicate *H. pylori*. PRILOSEC, in combination with clarithromycin, is also indicated for treatment of patients with *H. pylori* infection and duodenal ulcer disease to eradicate *H. pylori*. Eradication of *H. pylori* has been shown to reduce the risk of duodenal ulcer recurrence. Among patients who fail therapy, PRILOSEC with clarithromycin is more likely to be associated with the development of clarithromycin resistance as compared with triple therapy. In patients who fail therapy, susceptibility testing should be done. If resistance to clarithromycin is demonstrated or susceptibility testing is not possible, alternative antimicrobial therapy should be instituted. (See the clarithromycin package insert, MICROBIOLOGY section.) **Gastric Ulcer:** PRILOSEC is indicated for short-term treatment (4-8 weeks) of active benign gastric ulcer. **Treatment of Gastroesophageal Reflux Disease (GERD):** *Symptomatic GERD*— PRILOSEC is indicated for the treatment of heartburn and other symptoms associated with GERD. *Erosive Esophagitis*— PRILOSEC is indicated for the short-term treatment (4-8 weeks) of erosive esophagitis which has been diagnosed by endoscopy. The efficacy of PRILOSEC used for longer than 8 weeks in these patients has not been established. In the rare instance of a patient not responding to 8 weeks of treatment, it may be helpful to give up to an additional 4 weeks of treatment. If there is recurrence of erosive esophagitis or GERD symptoms (e.g., heartburn), additional 4-8 week courses of omeprazole may be considered. **Maintenance of Healing of Erosive Esophagitis:** PRILOSEC is indicated to maintain healing of erosive esophagitis. Controlled studies do not extend beyond 12 months. **Pathological Hypersecretory Conditions:** PRILOSEC is indicated for the long-term treatment of pathological hypersecretory conditions (e.g., Zollinger-Ellison syndrome, multiple endocrine adenomas and systemic mastocytosis).

CONTRAINDICATIONS, Omeprazole: PRILOSEC Delayed-Release Capsules are contraindicated in patients with known hypersensitivity to any component of the formulation. **Clarithromycin:** Clarithromycin is contraindicated in patients with a known hypersensitivity to any macrolide antibiotic. Concomitant administration of clarithromycin with cisapride, pimozide, or terfenadine is contraindicated. There have been post-marketing reports of drug interactions when clarithromycin and/or erythromycin are co-administered with cisapride, pimozide, or terfenadine resulting in cardiac arrhythmias (QT prolongation, ventricular tachycardia, ventricular fibrillation, and torsades de pointes) most likely due to inhibition of hepatic metabolism of these drugs by erythromycin and clarithromycin. Fatalities have been reported. (Please refer to full prescribing information for clarithromycin before prescribing.) **Amoxicillin:** Amoxicillin is contraindicated in patients with a history of allergic reaction to any of the penicillins. (Please refer to full prescribing information for amoxicillin before prescribing.)

WARNINGS, Clarithromycin: CLARITHROMYCIN SHOULD NOT BE USED IN PREGNANT WOMEN EXCEPT IN CLINICAL CIRCUMSTANCES WHERE NO ALTERNATIVE THERAPY IS APPROPRIATE. IF PREGNANCY OCCURS WHILE TAKING CLARITHROMYCIN, THE PATIENT SHOULD BE APPRISED OF THE POTENTIAL HAZARD TO THE FETUS. (See WARNINGS in prescribing information for clarithromycin.) Amoxicillin: SERIOUS AND OCCASIONALLY FATAL HYPERSENSITIVITY (anaphylactic) REACTIONS HAVE BEEN REPORTED IN PATIENTS ON PENICILLIN THERAPY. THESE REACTIONS ARE MORE LIKELY TO OCCUR IN INDIVIDUALS WITH A HISTORY OF PENICILLIN HYPERSENSITIVITY AND/OR A HISTORY OF SENSITIVITY TO MULTIPLE ALLERGENS. BEFORE INITIATING THERAPY WITH AMOXICILLIN, CAREFUL INQUIRY SHOULD BE MADE CONCERNING PREVIOUS HYPERSENSITIVITY REACTIONS TO PENICILLINS, CEPHALOSPORINS OR OTHER ALLERGENS. IF AN ALLERGIC REACTION OCCURS, AMOXICILLIN SHOULD BE DISCONTINUED AND APPROPRIATE THERAPY INSTITUTED. **SERIOUS ANAPHYLACTIC REACTIONS REQUIRE IMMEDIATE EMERGENCY TREATMENT WITH EPINEPHRINE. OXYGEN, INTRAVENOUS STEROIDS AND AIRWAY MANAGEMENT, INCLUDING INTUBATION, SHOULD ALSO BE ADMINISTERED AS INDICATED.** (See WARNINGS in prescribing information for amoxicillin.) **Antimicrobials: Pseudomembranous colitis has been reported with nearly all antibacterial agents and may range in severity from mild to life-threatening. Therefore, it is important to consider this diagnosis in patients who present with diarrhea subsequent to the administration of antibacterial agents.** (See WARNINGS in prescribing information for clarithromycin and amoxicillin.)

PRECAUTIONS, General: Symptomatic response to therapy with omeprazole does not preclude the presence of gastric malignancy. Atrophic gastritis has been noted occasionally in gastric corpus biopsies from patients treated long-term with omeprazole. **Information for Patients:** PRILOSEC Delayed-Release Capsules should be taken before eating. Patients should be cautioned that the PRILOSEC Delayed-Release Capsule should not be opened, chewed or crushed, and should be swallowed whole. **Drug Interactions:** *Other*— Omeprazole can prolong the elimination of diazepam, warfarin and phenytoin, drugs that are metabolized by oxidation in the liver. Although in normal subjects no interaction with theophylline or propranolol was found, there have been clinical reports of interaction with other drugs metabolized via the cytochrome P-450 system (e.g., cyclosporine, disulfiram, benzodiazepines). Patients should be monitored to determine if it is necessary to adjust the dosage of these drugs when taken concomitantly with PRILOSEC. Because of its profound and long lasting inhibition of gastric acid secretion, it is theoretically possible that omeprazole may interfere with absorption of drugs where gastric pH is an important determinant of their bioavailability (e.g., ketoconazole, ampicillin esters, and iron salts). In the clinical trials, antacids were used concomitantly with the administration of PRILOSEC. *Combination Therapy with Clarithromycin*— Co-administration of omeprazole and clarithromycin have resulted in increases in plasma levels of omeprazole, clarithromycin, and 14-hydroxy-clarithromycin. (See CLINICAL PHARMACOLOGY, Pharmacokinetics: Combination Therapy with Antimi- crobials in full Prescribing Information.) Concomitant administration of clarithromycin with cisapride, pimozide, or terfenadine is contraindicated. There have been reports of an interaction between erythromycin and astemizole resulting in QT prolongation and torsades de pointes. Concomitant administration of erythromycin and astemizole is contraindicated. Because clarithromycin is also metabolized by cytochrome P-450, concomitant administration of clarithromycin with astemizole is not recommended. (See also CONTRAINDICATIONS, Clarithromycin, above. Please refer to full prescribing information for clarithromycin before prescribing.) **Carcinogenesis, Mutagenesis, Impairment of Fertility:** In two 24-month carcinogenicity studies in rats, omeprazole at daily doses of 1.7, 3.4, 13.8, 44.0 and 140.8 mg/kg/day (approximately 4 to 352 times the human dose, based on a patient weight of 50 kg and a human dose of 20 mg) produced gastric ECL cell carcinoids in a dose-related manner in both male and female rats; the incidence of this effect was markedly higher in female rats, which had higher blood levels of omeprazole. Gastric carcinoids seldom occur in the untreated rat. In addition, ECL cell hyperplasia was present in all treated groups of both sexes. In one of these studies, female rats were treated with 13.8 mg/kg/day omeprazole (approximately 35 times the human dose) for 1 year, then followed for an additional year without the drug. No carcinoids were seen in these rats. An increased incidence of treatment-related ECL cell hyperplasia was observed at the end of 1 year (94% treated vs 10% controls). By the second year the difference between treated and control rats was much smaller (46% vs 26%) but still showed more hyperplasia in the treated group. An unusual primary malignant tumor in the stomach was seen in one rat (2%). No similar tumor was seen in male or female rats treated for 2 years. For this strain of rat no similar tumor has been noted historically, but a finding involving only one tumor is difficult to interpret. A 78-week mouse carcinogenicity study of omeprazole did not show increased tumor occurrence, but the study was not conclusive. Omeprazole was not mutagenic in an *in vitro* Ames *Salmonella typhimurium* assay, an *in vitro* mouse lymphoma cell assay and an *in vivo* rat liver DNA damage assay. A mouse micronucleus test at 625 and 6250 times the human dose gave a borderline result, as did an *in vivo* bone marrow chromosome aberration test. A second mouse micronucleus study at 2000 times the human dose, but with different (suboptimal) sampling times, was negative. **Pregnancy: Omeprazole:** *Pregnancy Category C*— In rabbits, omeprazole in a dose range of 6.9 to 69.1 mg/kg/day (approximately 17 to 172 times the human dose) produced dose-related increases in embryo-lethality, fetal resorptions and pregnancy disruptions. In rats, dose-related embryo/fetal toxicity and postnatal developmental toxicity were observed in offspring resulting from parents treated with omeprazole 13.8 to 138.0 mg/kg/day (approximately 35 to 345 times the human dose). There are no adequate or well-controlled studies in pregnant women. Sporadic reports have been received of congenital abnormalities occurring in infants born to women who have received omeprazole during pregnancy. Omeprazole should be used during pregnancy only if the potential benefit justifies the potential risk to the fetus. **Clarithromycin:** *Pregnancy Category C*— See WARNINGS (above) and full prescribing information for clarithromycin before using in pregnant women. **Nursing Mothers:** It is not known whether omeprazole is excreted in human milk. In rats, omeprazole administration during late gestation and lactation at doses of 13.8 to 138 mg/kg/day (35 to 345 times the human dose) resulted in decreased weight gain in pups. Because many drugs are excreted in human milk, because of the potential for serious adverse reactions in nursing infants from omeprazole, and because of the potential for tumorigenicity shown for omeprazole in rat carcinogenicity studies, a decision should be made whether to discontinue nursing or discontinue the drug, taking into account the importance of the drug to the mother. **Pediatric Use:** Safety and effectiveness in pediatric patients have not been established.

ADVERSE REACTIONS: In the U.S. clinical trial population of 465 patients (including duodenal ulcer, Zollinger-Ellison syndrome and resistant ulcer patients), the following adverse experiences were reported to occur in 1% or more of patients on therapy with PRILOSEC® (omeprazole). Numbers in parentheses indicate percentages of the adverse experiences considered by investigators as possibly, probably, or definitely related to the drug.

	Omeprazole (n=465)	Placebo (n=64)	Ranitidine (n=195)
Headache	6.9 (2.4)	6.3	7.7 (2.6)
Diarrhea	3.0 (1.9)	3.1 (1.6)	2.1 (0.5)
Abdominal Pain	2.4 (0.4)	3.1	2.1
Nausea	2.2 (0.9)	3.1	4.1 (0.5)
URI	1.9	1.6	2.6
Dizziness	1.5 (0.6)	0.0	2.6 (1.0)
Vomiting	1.5 (0.4)	4.7	1.5 (0.5)
Rash	1.5 (1.1)	0.0	0.0
Constipation	1.1 (0.9)	0.0	0.0
Cough	1.1	0.0	1.5
Asthenia	1.1 (0.2)	1.6 (1.6)	1.5 (1.0)
Back Pain	1.1	0.0	0.5

The following adverse reactions which occurred in 1% or more of omeprazole-treated patients have been reported in international double-blind, and open-label, clinical trials in which 2,631 patients and subjects received omeprazole.

Incidence of Adverse Experiences ≥ 1% Causal Relationship not Assessed

		Omeprazole (n=2,631)	Placebo (n=120)
Body as a Whole, site unspecified	Abdominal pain	5.2	3.3
	Asthenia	1.3	0.8
Digestive System	Constipation	1.5	0.8
	Diarrhea	3.7	2.5
	Flatulence	2.7	5.8
	Nausea	4.0	6.7
	Vomiting	3.2	10.0
	Acid regurgitation	1.9	3.3
Nervous System/Psychiatric	Headache	2.9	2.5

Additional adverse experiences occurring in <1% of patients or subjects in domestic and/or international trials, or occurring since the drug was marketed, are shown below within each body system. In many instances, the relationship to PRILOSEC was unclear. *Body As a Whole:* Allergic reactions including, rarely, anaphylaxis (see also *Skin* below), fever, pain, fatigue, malaise, abdominal swelling. *Cardiovascular:* Chest pain or angina, tachycardia, bradycardia, palpitation, elevated blood pressure, peripheral edema. *Gastrointestinal:* Pancreatitis (some fatal), anorexia, irritable colon, flatulence, fecal discoloration, esophageal candidiasis, mucosal atrophy of the tongue, dry mouth. During treatment with omeprazole, gastric fundic gland polyps have been noted rarely. These polyps are benign and appear to be reversible when treatment is discontinued. Gastro-duodenal carcinoids have been reported in patients with ZE syndrome on long-term treatment with PRILOSEC. This finding is believed to be a manifestation of the underlying condition, which is known to be associated with such tumors. *Hepatic:* Mild and, rarely, marked elevations of liver function tests [ALT (SGPT), AST (SGOT), γ-glutamyl transpeptidase, alkaline phosphatase, and bilirubin (jaundice)]. In rare instances, overt liver disease has occurred, including hepatocellular, cholestatic, or mixed hepatitis, liver necrosis (some fatal), hepatic failure (some fatal), and hepatic encephalopathy. *Metabolic/Nutritional:* Hyponatremia, hypoglycemia, weight gain. *Musculoskeletal:* Muscle cramps, myalgia, muscle weakness, joint pain, leg pain. *Nervous System/Psychiatric:* Psychic disturbances including depression, aggression, hallucinations, confusion, insomnia, nervousness, tremors, apathy, somnolence, anxiety, dream abnormalities; vertigo; paresthesia; hemifacial dysesthesia. *Respiratory:* Epistaxis, pharyngeal pain. *Skin:* Rash and, rarely, cases of severe generalized skin reactions including toxic epidermal necrolysis (TEN; some fatal), Stevens-Johnson syndrome, and erythema multiforme (some severe); purpura and/or petechiae (some with rechallenge); skin inflammation, urticaria, angioedema, pruritus, alopecia, dry skin, hyperhidrosis. *Special Senses:* Tinnitus, taste perversion. *Urogenital:* Interstitial nephritis (some with positive rechallenge), urinary tract infection, microscopic pyuria, urinary frequency, elevated serum creatinine, proteinuria, hematuria, glycosuria, testicular pain, gynecomastia. *Hematologic:* Rare instances of pancytopenia, agranulocytosis (some fatal), thrombocytopenia, neutropenia, anemia, leucocytosis, and hemolytic anemia have been reported. **Combination Therapy for *H. pylori* Eradication:** dual therapy with PRILOSEC and clarithromycin or triple therapy with PRILOSEC, clarithromycin, and amoxicillin. Adverse experiences that have occurred have been limited to those that have been previously reported with omeprazole, clarithromycin, or amoxicillin. *Triple Therapy (PRILOSEC/clarithromycin/amoxicillin)*— The most frequent adverse experiences observed in clinical trials using combination therapy with PRILOSEC, clarithromycin, and amoxicillin (n = 274) were diarrhea (14%), taste perversion (10%), and headache (7%). None of these occurred at a higher frequency than that reported by patients taking the antimicrobial drugs alone. *Dual Therapy (PRILOSEC/clarithromycin)*— Adverse experiences observed in controlled clinical trials using combination therapy with PRILOSEC and clarithromycin (n = 346) which differed from those previously described for omeprazole alone were: Taste perversion (15%), tongue discoloration (2%), rhinitis (2%), pharyngitis (1%) and flu syndrome (1%). For more information on clarithromycin or amoxicillin, refer to the respective package inserts, ADVERSE REACTIONS sections.

OVERDOSAGE: Rare reports have been received of overdosage with omeprazole. Doses ranged from 320 mg to 900 mg (16-45 times the usual recommended clinical dose). Manifestations were variable, but included confusion, drowsiness, blurred vision, tachycardia, nausea, diaphoresis, flushing, headache, and dry mouth. Symptoms were transient, and no serious clinical outcome has been reported. No specific antidote for omeprazole overdosage is known. Omeprazole is extensively protein bound and is, therefore, not readily dialyzable. In the event of overdosage, treatment should be symptomatic and supportive.

DOSAGE AND ADMINISTRATION, Short-Term Treatment of Active Duodenal Ulcer: The recommended adult oral dose of PRILOSEC is 20 mg once daily. Most patients heal within 4 weeks. Some patients may require an additional 4 weeks of therapy. (See INDICATIONS AND USAGE.) ***H. pylori* Eradication for the Reduction of the Risk of Duodenal Ulcer Recurrence:** *Triple Therapy (PRILOSEC/clarithromycin/amoxicillin)*— The recommended adult oral regimen is PRILOSEC 20 mg plus clarithromycin 500 mg plus amoxicillin 1000 mg each given twice daily for 10 days. In patients with an ulcer present at the time of initiation of therapy, an additional 18 days of PRILOSEC 20 mg once daily is recommended for ulcer healing and symptom relief. *Dual Therapy (PRILOSEC/clarithromycin)*— The recommended adult oral regimen is PRILOSEC 40 mg once daily plus clarithromycin 500 mg t.i.d. for 14 days. In patients with an ulcer present at the time of initiation of therapy, an additional 14 days of PRILOSEC 20 mg once daily is recommended for ulcer healing and symptom relief. Please refer to clarithromycin full prescribing information for CONTRAINDICATIONS and WARNING, and for information regarding dosing in elderly and renally impaired patients (PRECAUTIONS: General, PRECAUTIONS: Geriatric Use and PRECAUTIONS: Drug Interactions). Please refer to amoxicillin full prescribing information for CONTRAINDICATIONS and WARNINGS. **Gastric Ulcer:** The recommended adult oral dose is 40 mg once a day for 4 to 8 weeks. (See INDICATIONS AND USAGE, Gastric Ulcer.) **Gastroesophageal Reflux Disease (GERD):** The recommended adult oral dose for the treatment of patients with symptomatic GERD and no esophageal lesions is 20 mg daily for up to 4 weeks. The recommended adult oral dose for the treatment of patients with erosive esophagitis and accompanying symptoms due to GERD is 20 mg daily for 4 to 8 weeks. (See INDICATIONS AND USAGE.) **Maintenance of Healing of Erosive Esophagitis:** The recommended adult oral dose is 20 mg daily. **Pathological Hypersecretory Conditions:** The dosage of PRILOSEC in patients with pathological hypersecretory conditions varies with the individual patient. The recommended adult oral starting dose is 60 mg once a day. Doses should be adjusted to individual patient needs and should continue for as long as clinically indicated. Doses up to 120 mg t.i.d. have been administered. Daily dosages of greater than 80 mg should be administered in divided doses. No dosage adjustment is necessary for patients with renal impairment, hepatic dysfunction or for the elderly.

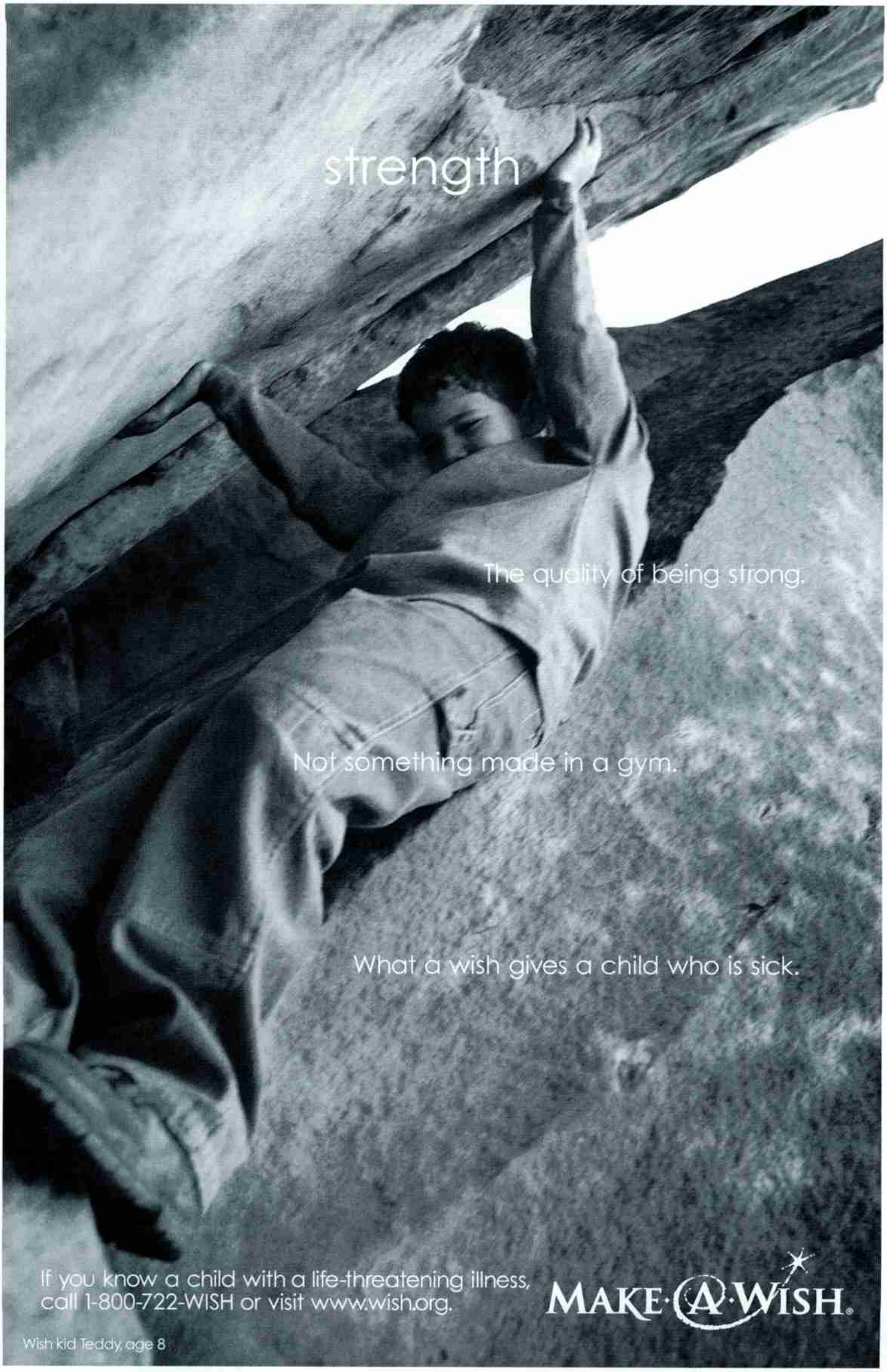
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NOTE: This summary provides important information about PRILOSEC. If you would like more information, ask your doctor or pharmacist to let you read the professional labeling and then discuss it with them.

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NATIONAL GEOGRAPHIC

Behind the Scenes



NGS PHOTOGRAPHER MARK THIESSEN (ABOVE); J.D. SCOTT

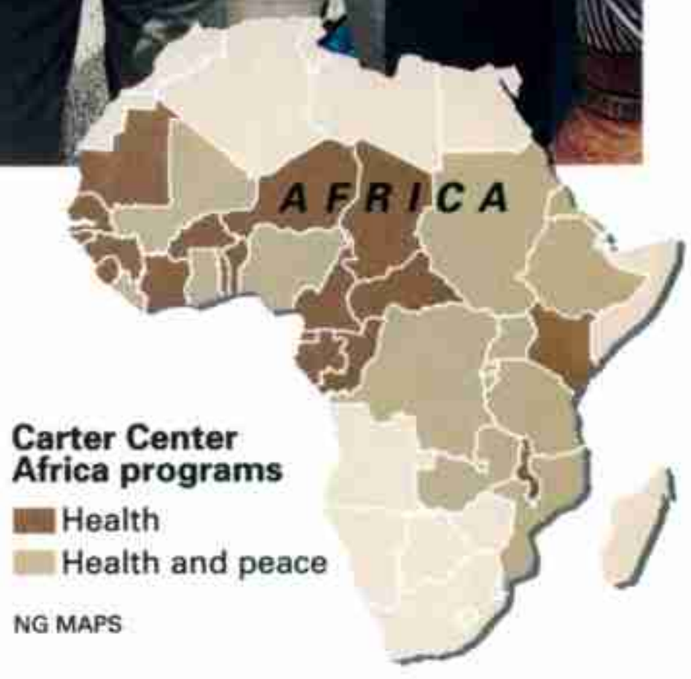
Jimmy Carter Reaches Out

The Society got a presidential visit in January—and the visiting dignitary got a surprise. When former President Jimmy Carter arrived at headquarters to address our staff and guests, we had his grandson, Jason Carter, who has been stationed in South Africa with the Peace Corps, waiting to greet him. Jason, 24 (above, with his grandparents), also spoke—about his life and work in a former South African homeland. "If your grandfather was King of America," he said a man once asked him, "why are you here?"

President Carter and his wife, Rosalynn (right, in Mali), have a deep interest in Africa, a place they visit often and describe as "one of the most deprived continents on Earth." Their nonprofit, nonpartisan Carter Center is involved with numerous health and peace initiatives there (map, right), including fighting diseases such as river blindness, trachoma, and schistosomiasis. Because of programs spearheaded by the center, the parasitic illness known as guinea worm disease has been reduced worldwide by 97 percent.

"Despite the U.S.'s tremendous contributions and power, the world is still waiting for this nation to lead the effort to alleviate suffering," said President Carter in his Society speech. "I hope we can find a way to transform the despair that people feel into hope and expectation of a better life."





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GERVAIS COURTELLEMONT



JOSEPH F. ROCK

Autochromes in Living Color

The Autochrome process allowed the GEOGRAPHIC to be among the first magazines to bloom with color photography. "Not many people made Autochromes," says Society conservator Robin Siegel. "It was expensive and too much work." Despite long exposures and complex processing, scenes such as this French landscape from 1925 (above), never before published in the magazine, made the work worth the wait. The Society's large Autochrome collection numbers some 10,000 images—including a Hopi potter (below) from our September 1916 issue and Tibetan dancer (left) from November 1928.



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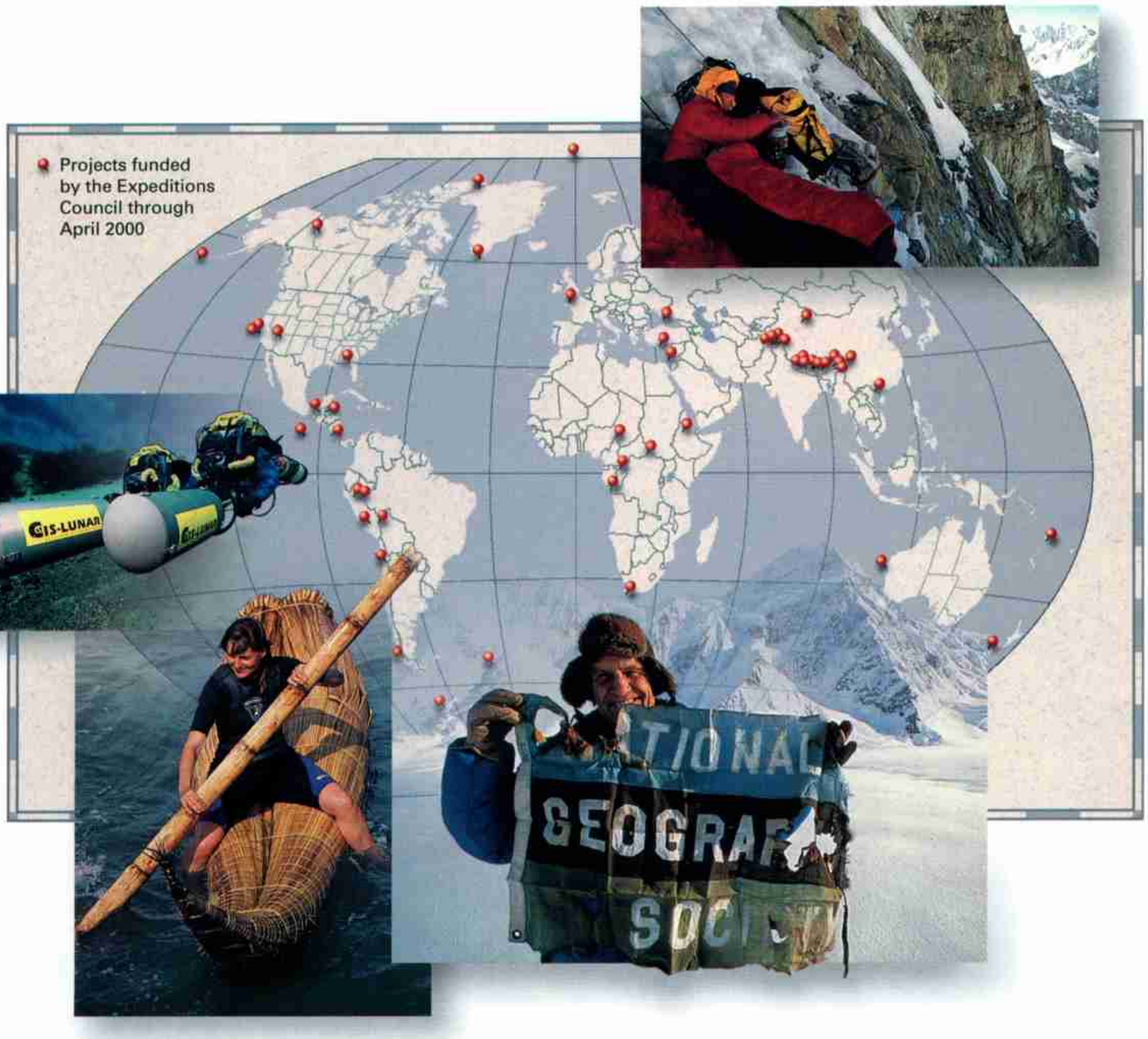
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Exploring the Possibilities

In the two years since its founding the National Geographic Expeditions Council has granted more than three million dollars to explorers all over the map (above). Expeditions have always helped further the Society's mission. Now the council gives them a framework to provide material for our magazines, films, books, lectures, and website as stories pour in from adventurers like these (clockwise, from top).

Kitty Calhoun—perched in a sleeping bag after a night on a 17,500-foot-high rock face—forged two-thirds of the way up Pakistan's Latok III before bad weather forced her back. Bradford Washburn determined the precise position and altitude of Mount Everest. Explorer Karin Muller's journey along South America's Royal Inca Highway included a wild ride in a traditional reed boat she made herself. Scientist and diver Bill Stone charted Wakulla Springs in Florida, producing the first ever three-dimensional digital subterranean map.

"Modern exploration isn't about being the first to see new places," says Rebecca Martin, the council's director. "It's about seeing places in new ways."

CLOCKWISE FROM TOP: JAY SMITH, KAREN KUEHN, ASHTON PALMER, STEVEN J. AVER



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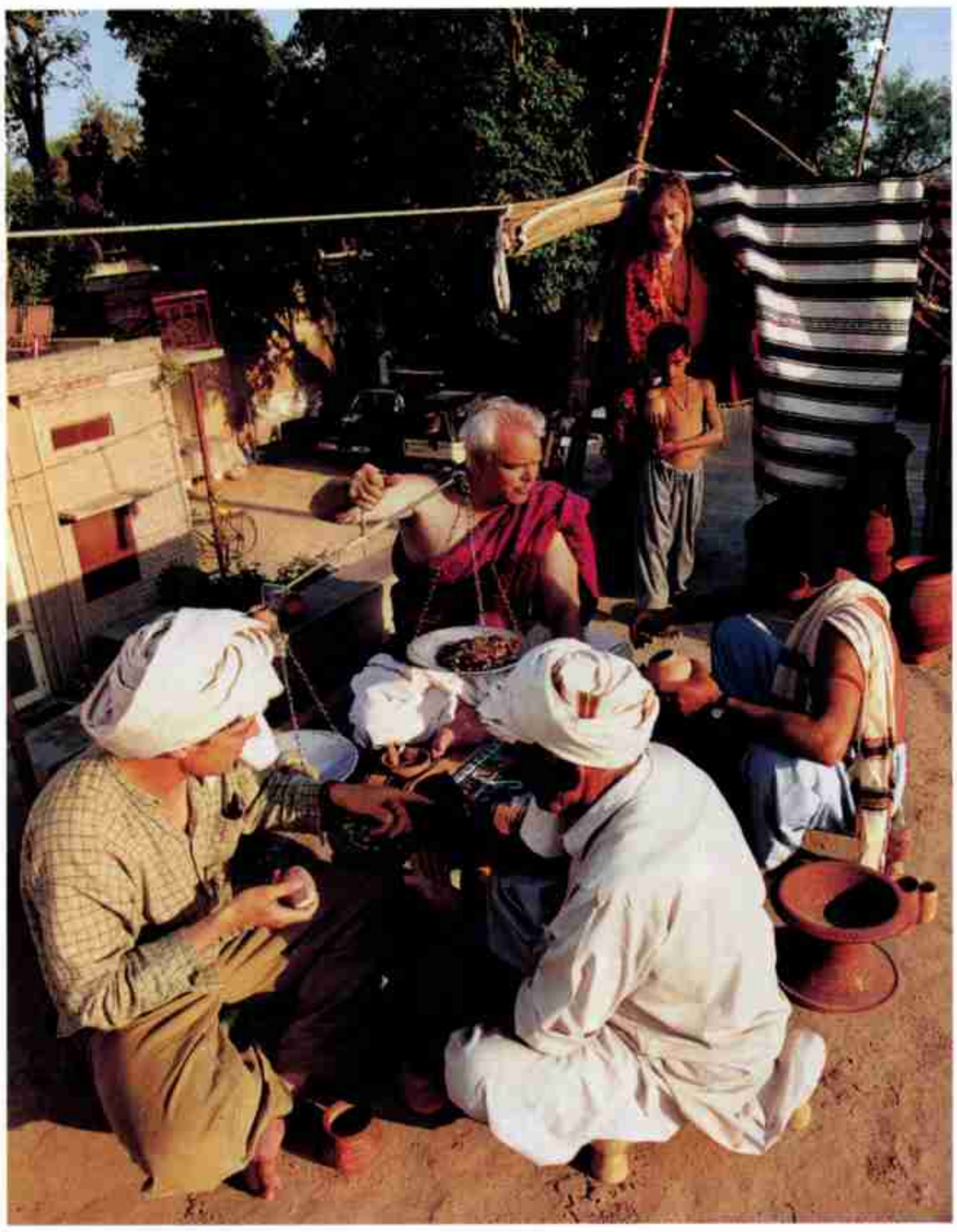
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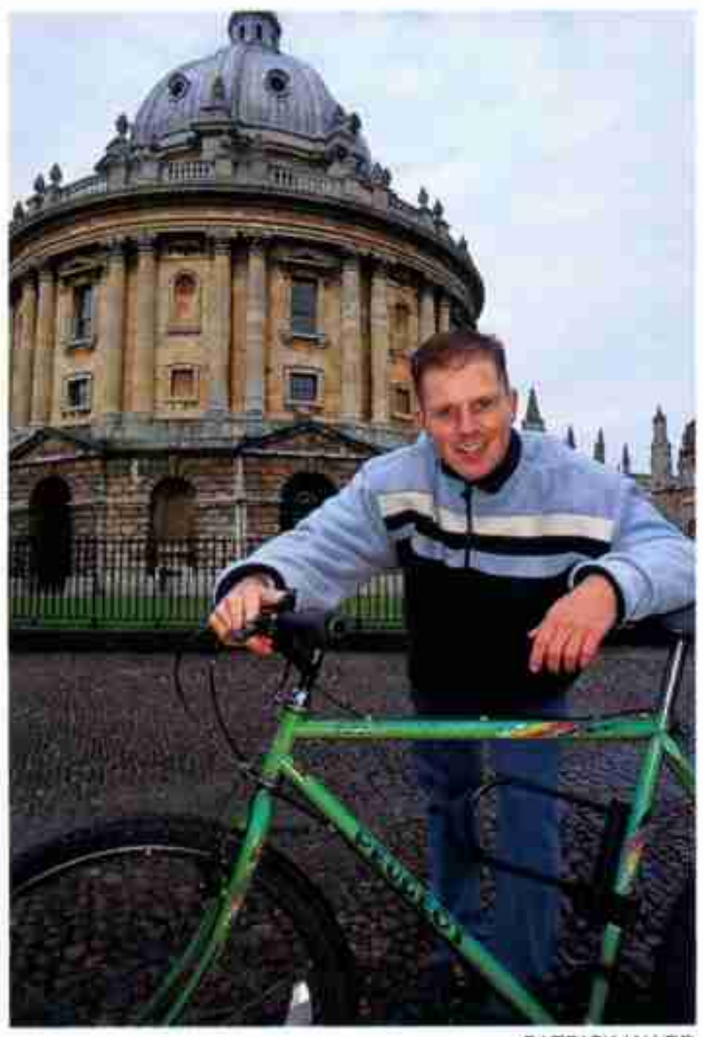
Drawn From Life

"Photographs are able to tell you what a place looks like now," says GEOGRAPHIC artist Christopher A. Klein, whose paintings appear in this issue's "Indus Civilization" article. "But artwork is able to tell you what a place might have looked like thousands of years ago."

First the artist has to get a feel for the place he's painting. Chris spent ten days at the archaeological site of Harappa, Pakistan, though the place today hardly resembles the bustling center of commerce it was in ancient times. The photograph he made (left) to use as a skeleton for the jewel-trading scene on page 127 was shot on a rooftop located approximately where the market would have been in 2600 B.C., says Chris. The place would have looked different 4,600 years ago. To envision specific postures and gestures, Chris made use of "models" already on the scene. The silver-haired merchant holding the scale is one of the site's chief archaeologists, Society grantee Mark Kenoyer. A graduate student from Kenoyer's classes at the University of Wisconsin, team members, and locals helping with the excavation fill out the picture.

Winning Ways in Oxford

Every year since 1993 the National Geographic Society in conjunction with the British Cartographic Society has awarded a scholarship to recognize outstanding student achievement in mapmaking in the United Kingdom. The 1999 winner was 20-year-old Oxford Brookes University student David Scott (below), who received 500 pounds sterling (about $800) and the new seventh edition of the *National Geographic Atlas of the World.*



PATRICK WARD

Dave was thrilled to be the first person in Britain to receive the atlas, which he calls "absolutely brilliant," but the cash award was appreciated too. He used it to buy a new computer.

Dave's winning project involved the creation of a tourist pamphlet—including bicycle routes—for southern England's Purbeck region in Dorset.

Taking Note of Korea

When NGS Senior Vice President Terry Adamson met South Korean President Kim Dae-jung while in Seoul for the announcement of our Korean-language edition, he had more than a magazine to show him. He gave Kim the notes he'd taken 24 years ago as an Amnesty International observer during Kim's trial as a political prisoner.

TEXT BY MAGGIE ZACKOWITZ

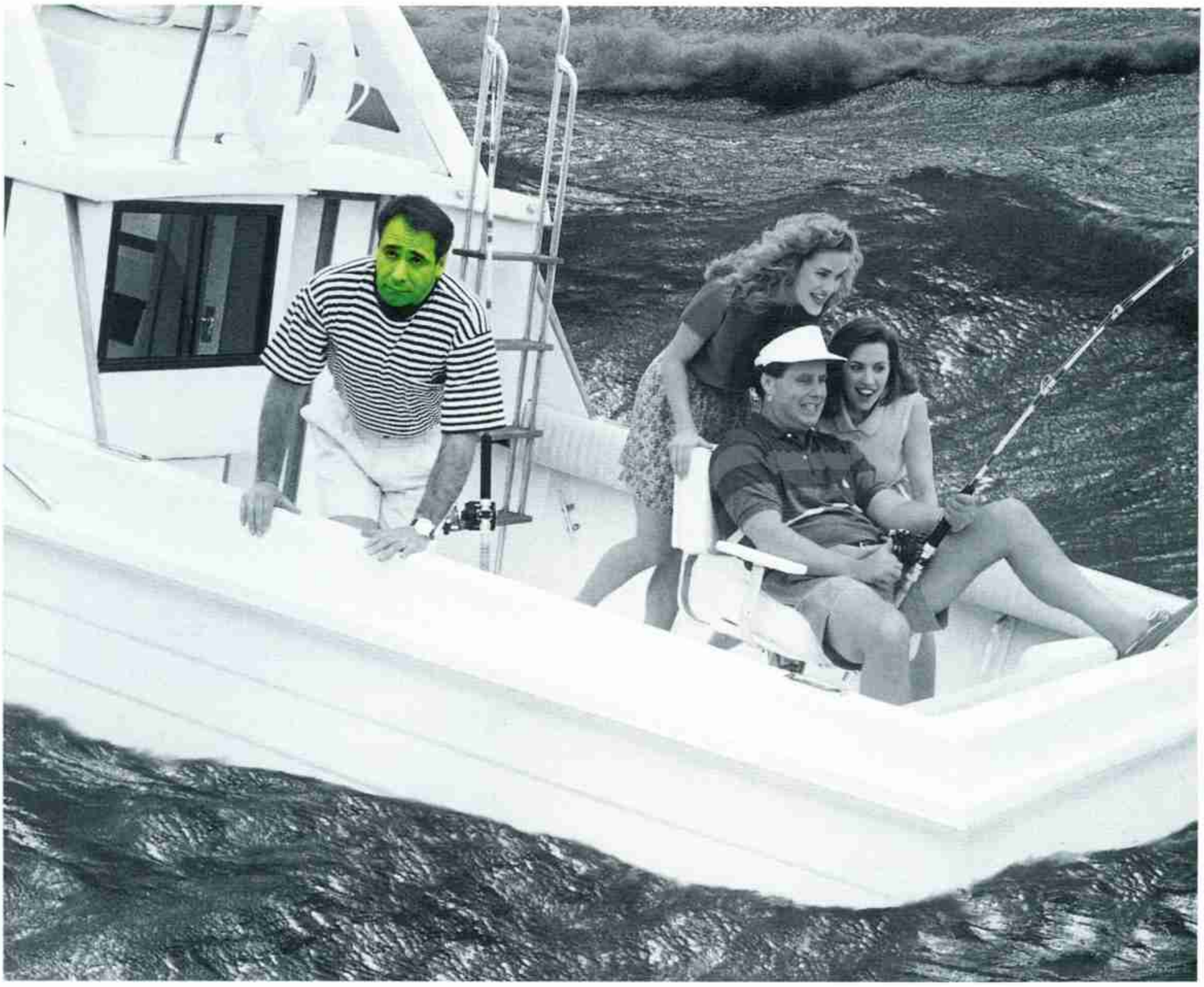
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The Transderm Scōp® patch is clinically proven more effective than Dramamine®*



Transderm Scōp is more effective and longer lasting than Dramamine**at preventing the nausea and vomiting of motion sickness.** Just peel off the backing and press it behind your ear at least four hours before boarding and relax. The medicine is consistently absorbed for up to three days. You can even shower with it. For shorter trips, remove the patch when no longer needed and the effects wear off. ***In clinical studies, 5 out of 6 people did not report drowsiness with Transderm Scōp.

Ask your doctor about Transderm Scōp when you make your travel plans.
Not for children or those with glaucoma, difficulty in urinating, or an allergy to scopolamine or other belladonna alkaloids. In clinical studies, some side effects were noted, including blurred vision, dryness of the mouth (in two-thirds of users) and drowsiness (reported incidence less than 1 in 6). While using this product, you should not drive, operate dangerous machinery or do other things that require alertness. Avoid using alcohol. If you are elderly, your physician should exercise special care in prescribing this product. See adjoining page for additional information on potential adverse reactions or side effects.
Available by prescription only.

TRANSDERM SCŌP®
scopolamine 1.5 mg
Transdermal Therapeutic System

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www.transdermscop.com

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*Compared to Dramamine Original Formula (dimenhydrinate) tablets. **Based on labeled dosage.

Transderm Scōp®
scopolamine 1.5 mg

Transdermal Therapeutic System

Programmed to deliver *in vivo* approximately 1.0 mg of scopolamine over 3 days.

Brief Summary
(For full prescribing information, see package insert.)

INDICATIONS AND USAGE: Transderm Scōp is indicated for prevention of nausea and vomiting associated with motion sickness in adults. The patch should be applied only to skin in the postauricular area.

CONTRAINDICATIONS: Transderm Scōp is specifically contraindicated in persons who are hypersensitive to the drug scopolamine or to other belladonna alkaloids, or to any ingredient or component in the formulation or delivery system, or in patients with angle-closure (narrow angle) glaucoma.

WARNINGS: Transderm Scōp should not be used in children and should be used with special caution in the elderly. See PRECAUTIONS.

Since drowsiness, disorientation, and confusion may occur with the use of scopolamine, patients should be warned of the possibility and cautioned against engaging in activities that require mental alertness, such as driving a motor vehicle or operating dangerous machinery.

Potentially alarming idiosyncratic reactions may occur with ordinary therapeutic doses of scopolamine.

PRECAUTIONS

General: Scopolamine should be used with caution in patients with pyloric obstruction, or urinary bladder neck obstruction. Caution should be exercised when administering an antiemetic or antimuscarinic drug to patients suspected of having intestinal obstruction.

Transderm Scōp should be used with special caution in the elderly or in individuals with impaired metabolic, liver, or kidney functions, because of the increased likelihood of CNS effects.

Caution should be exercised in patients with a history of seizure or psychosis, since scopolamine can potentially aggravate both disorders.

Information for Patients: Since scopolamine can cause temporary dilation of the pupils and blurred vision if it comes in contact with the eyes, patients should be strongly advised to wash their hands thoroughly with soap and water immediately after handling the patch. In addition, it is important that used patches be disposed of properly to avoid contact with children or pets.

Patients should be advised to remove the patch immediately and contact a physician in the unlikely event that they experience symptoms of acute narrow-angle glaucoma (pain in and reddening of the eyes accompanied by dilated pupils). Patients should also be instructed to remove the patch if they develop any difficulties in urinating.

Patients should be warned against driving a motor vehicle or operating dangerous machinery while wearing the patch. Patients who engage in these activities should also be aware of the possibility of withdrawal symptoms when the patch is removed. Patients who expect to participate in underwater sports should be cautioned regarding the potentially disorienting effects of scopolamine. A patient brochure is available.

Drug Interactions: Scopolamine should be used with care in patients taking drugs, including alcohol, capable of causing CNS effects. Special attention should be given to drugs having anticholinergic properties, e.g., belladonna alkaloids, antihistamines (including meclizine), and anti-depressants.

Carcinogenesis, Mutagenesis, Impairment of Fertility: No long-term studies in animals have been performed to evaluate carcinogenic potential. Fertility studies were performed in female rats and revealed no evidence of impaired fertility or harm to the fetus due to scopolamine hydrobromide administered by daily subcutaneous injection. In the highest-dose group (plasma level approximately 500 times the level achieved in humans using a transdermal system), reduced maternal body weights were observed.

Pregnancy Category C: Teratogenic studies were performed in pregnant rats and rabbits with scopolamine hydrobromide administered by daily intravenous injection. No adverse effects were recorded in the rats. In the rabbits, the highest dose (plasma level approximately 100 times the level achieved in humans using a transdermal system) of drug administered had a marginal embryotoxic effect. Transderm Scōp should be used during pregnancy only if the anticipated benefit justifies the potential risk to the fetus.

Nursing Mothers: It is not known whether scopolamine is excreted in human milk. Because many drugs are excreted in human milk, caution should be exercised when Transderm Scōp is administered to a nursing woman.

Pediatric Use: Children are particularly susceptible to the side effects of belladonna alkaloids. Transderm Scōp should not be used in children because it is not known whether this system will release an amount of scopolamine that could produce serious adverse effects in children.

ADVERSE REACTIONS: The most frequent adverse reaction to Transderm Scōp is dryness of the mouth. This occurs in about two thirds of the people. A less frequent adverse reaction is drowsiness, which occurs in less than one sixth of the people. Transient impairment of eye accommodation, including blurred vision and dilation of the pupils, is also observed.

The following adverse reactions have also been reported on infrequent occasions during the use of Transderm Scōp: disorientation; memory disturbances; dizziness; restlessness; hallucinations; confusion; difficulty urinating; rashes and erythema; acute narrow-angle glaucoma; and dry, itchy, or red eyes.

Drug Withdrawal: Symptoms including dizziness, nausea, vomiting, headache, and disturbances of equilibrium have been reported in a few patients following discontinuation of the use of the Transderm Scōp system. These symptoms have occurred most often in patients who have used the system for more than three days.

OVERDOSAGE: Overdosage with scopolamine may cause disorientation, memory disturbances, dizziness, restlessness, hallucinations, confusion, psychosis, convulsions, bronchospasm and respiratory depression, and muscular weakness. Should these symptoms occur, the Transderm Scōp patch should be removed immediately, adequate hydration should be maintained, and appropriate symptomatic treatment initiated.

CAUTION: Federal law prohibits dispensing without prescription.

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NATIONAL GEOGRAPHIC

CartoGraphic

Finding Clear Pathways for a Wireless World

The information age has created an enormous demand for fast and cheap ways to move large amounts of data from one place to another.

Old-fashioned wires may work, but they are easily overwhelmed by floods of data. Fiber-optic lines are effective, but installation is expensive—and tears up city streets.

With a relatively new technology called fixed wireless, a business's voice, data, and video signals are carried over a building's internal wiring to a rooftop antenna. The signals are beamed to a base-station antenna on another building—usually two or three miles distant—and then forwarded to either Internet or voice networks.

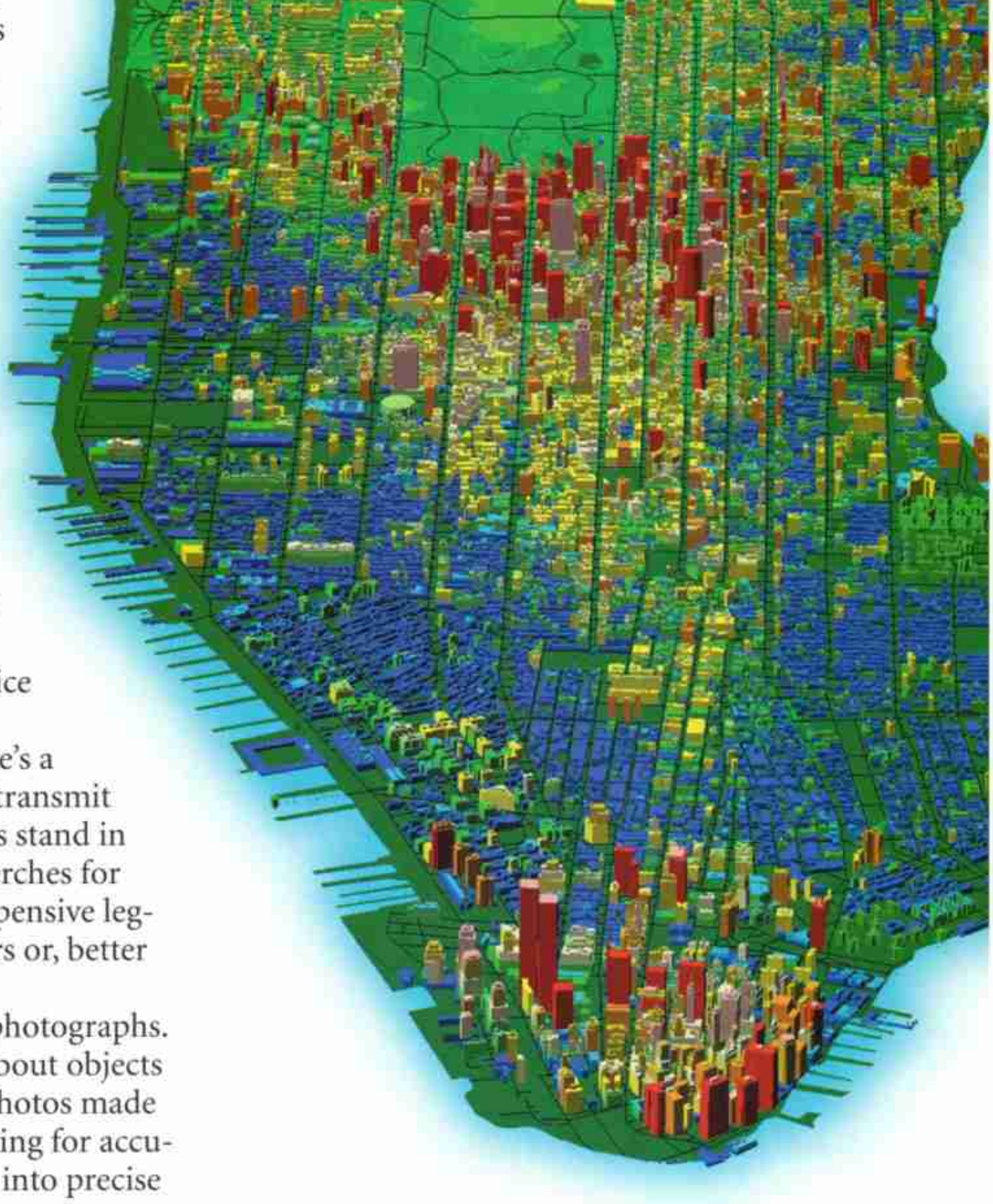
It's an elegant solution, but there's a hitch: Antennas can't successfully transmit or receive signals if other buildings stand in their way. Finding obstacle-free perches for antennas requires either lots of expensive legwork by binocular-toting engineers or, better yet, some clever mapping.

The process begins with aerial photographs. Three-dimensional information about objects can be coaxed from overlapping photos made from an airplane. After field checking for accuracy, the information is converted into precise 3-D maps. In the image above, Manhattan's buildings are color-coded by height.

But the work is not yet done. Line-of-sight analysis helps determine clear paths between antennas (A and B at right). Green areas are "visible" to the A antenna site; red areas are building "shadows."

Once the map is finished, the line-of-sight analysis can be done with a few clicks of a mouse.

TEXT BY ALLEN CARROLL
Chief Cartographer





BOTH BY TELIGENT, BASED ON DATA PROVIDED BY 3D-METRIC

A

is a PATIENT
who no longer thinks
he is less of a man.

is a FATHER
who teaches his son
the importance of
early detection.

is a SON
who comforts a mother
as she faces the challenge
of a lifetime.

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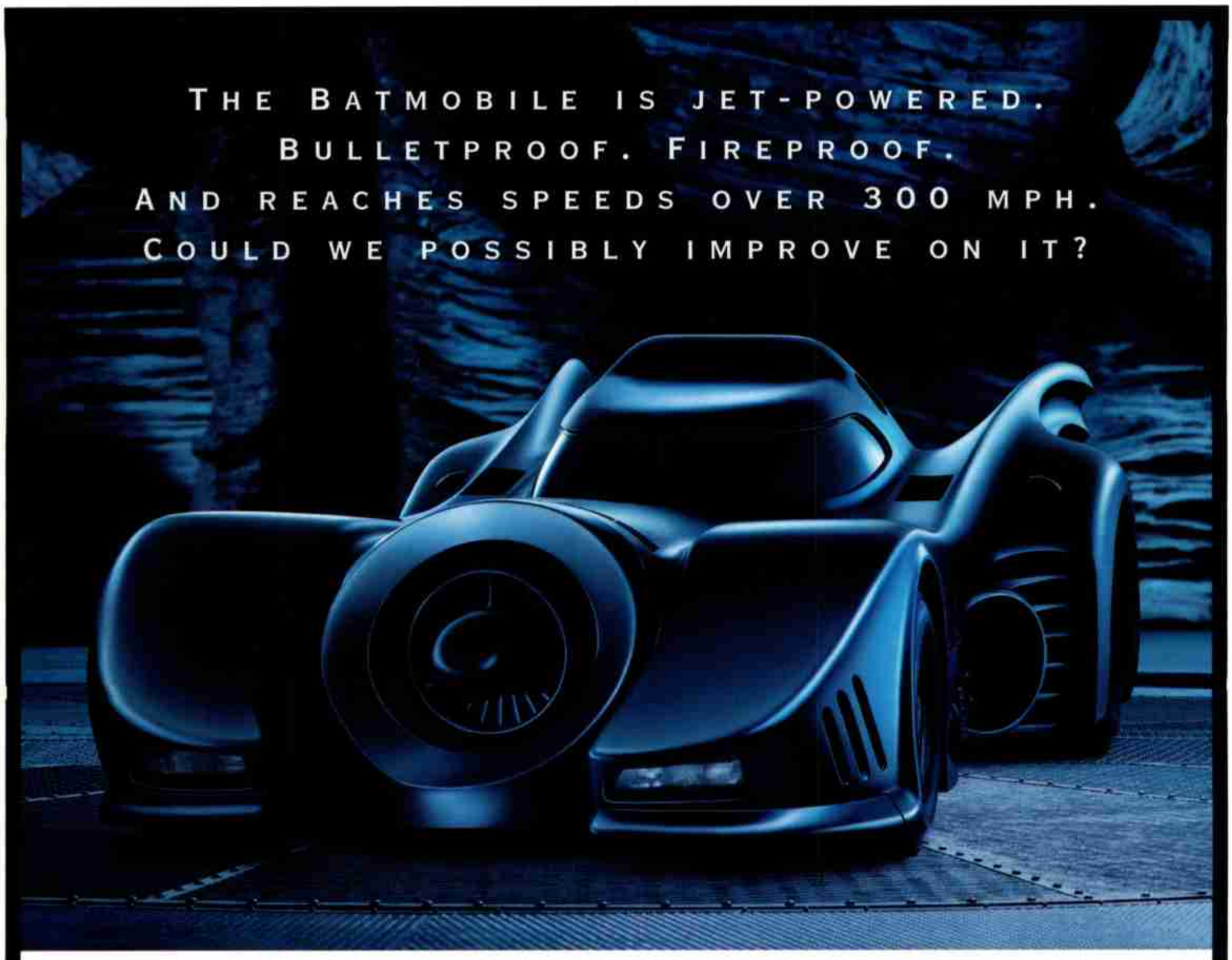
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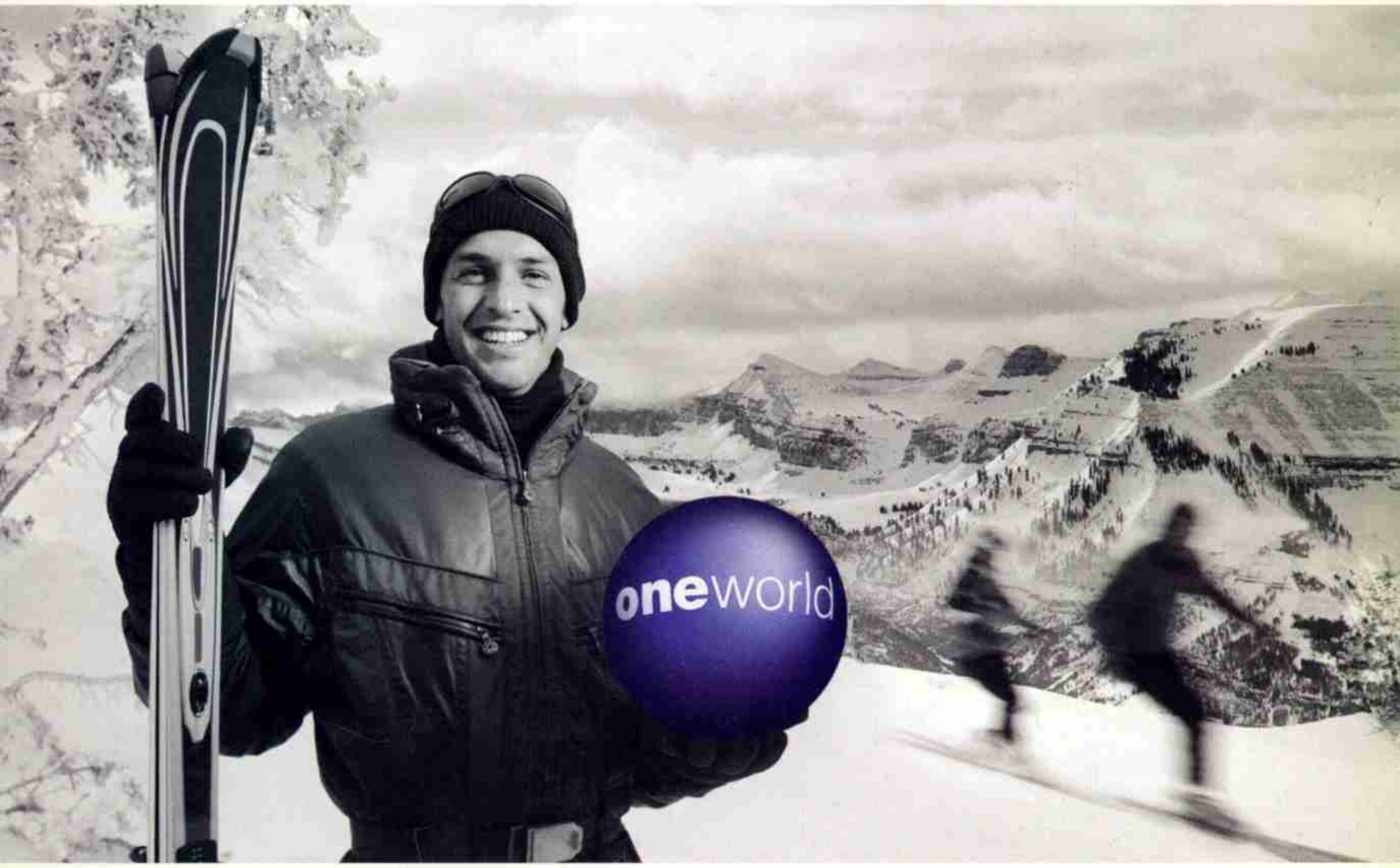
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